FIBER IN WAN

Wide Area Network Installations

As soon as we get outside buildings, we are dealing with challenges of a radically different nature. Enclosures must be waterproof, thermal fluctuations must be controlled and installations must be placed either in man holes or in street cabinets.

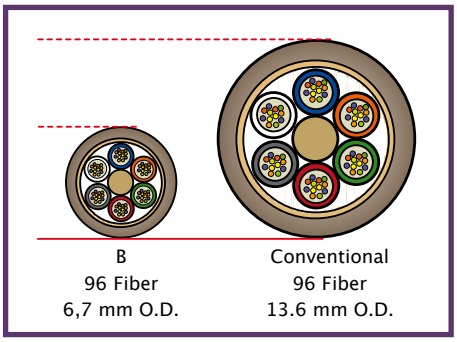
Outdoor installations are normally used for linking indoor installations together. Companies working within this field of work in Denmark are TDC (Tele Denmark Communications) and regional power plants, making FTTH (Fiber To The Home) installations. Yet, other operators are dealing with WAN too, Global Connect for example. It is an eye catching sight in the landscape to see the many orange tubes, intended for the blowing of fiber or cables. The cables and the fiber connect the different street cabinets and cable pits with the consumers.

A lively debate is going on, whether you should choose splicings, connectors or other passive components, when working with outdoor installations. In the USA they are very, very careful of making street cabinets as tight as possible. Here in Denmark we have not given much thought to this subject, so far. Whether we have made the right choice or not, will show in a few years. If we have chosen wrongly, a lot of corrections will have to be made.

You will have to choose whether the cables should be placed in the ground directly, or if they should be blown or flushed into ducts. Ducts have the advantage of being cheap to lay and then, when needed, you can put in the fiber cables. In theory, it will be possible to replace the cables at a later time, but there is a risk of the cables getting stuck in the tube – a problem you also may experience, when replacing old wires in a steel tube.

Looking at the existing types of cable there are three options. The standard type that can be placed directly in the ground, blown fiber in ducts, or the new micro cables, which are a little smaller. With regard to micro cables it is possible to place up to 96 fibers in a 10mm tube, which is quite impressive. However, micro cables are very sensitive with regard to pressure and you may not, under any circumstances, use cable ties when fixing cables.

Figure 1

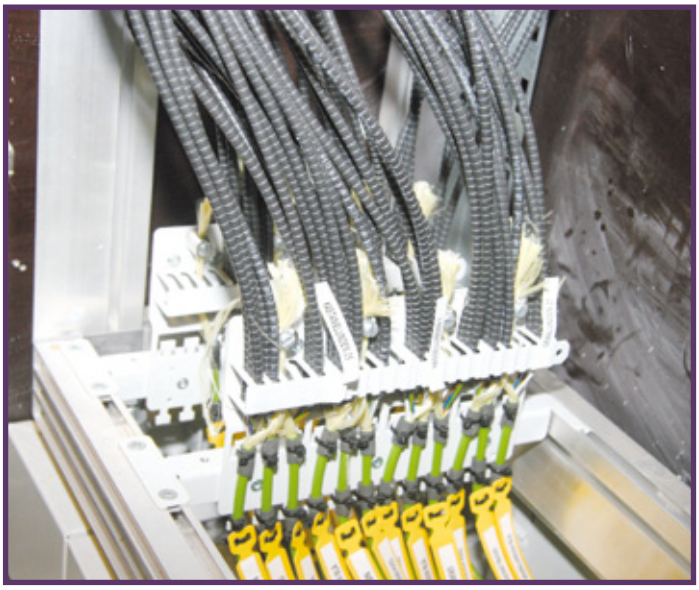


Proportions between conventional cable and micro cable

Figure 2

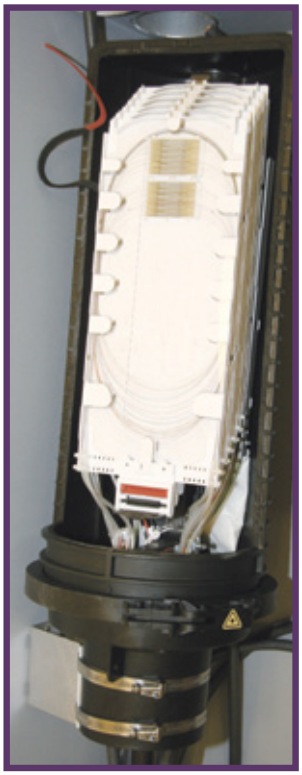
Micro fiber cables in tubes. Each tube contains 72 fibers.

Figure 3



The micro fiber cables are reliefed with foam tape and each single tube is taken into a protective tube, before entering the splicing cassette.

Figure 4



A coupling with conventional cassettes, a well known arrangement.

Figure 5

A coupling with Tyco cassettes. Each cassette contains fiber from only one customer, as opposed to conventional cassettes, in which fiber from many customers are mixed in one cassette.

Manholes

Manholes have the advantage of not being particulary visible, and the cover plates are very friendly to shock absorbers and drunken drivers. However, as problems concerning water in the manhole may occur, you must pay attention to the tightness of the cover plate.

Speaking of cover plates, it has become a problem to avoid fiber cables from being stolen. Typically, many meters of fiber are to be found in these manholes and for this reason, they now secure the cover plates.

Besides these problems you have to pay regard to temperature conditions. The installation will eventually break down, if the temperature is either too high or too low. Furthermore, there is allways a risk of malicious damage. Over time, I think we will see more and more precautions, as regards to fiber manholes.

Figure 6

A secured man hole.

Figure 7

An enclosure in a manhole

Street Cabinets

Street cabinets are easier to work with than manholes, but they do not exactly look nice the landscape, and they are sensitive to reckless driving and malicious damage. Regarding the use of street cabinets, some choose to install enclosures, others choose to install indoor cassettes. Street cabinets are available in many designs, but there is an increasing demand for a certain uniformity. In that respect, our local Danish manufacturers are on their toes (TRIAX).

Figure 8

Street cabinet, containing Tyco products.

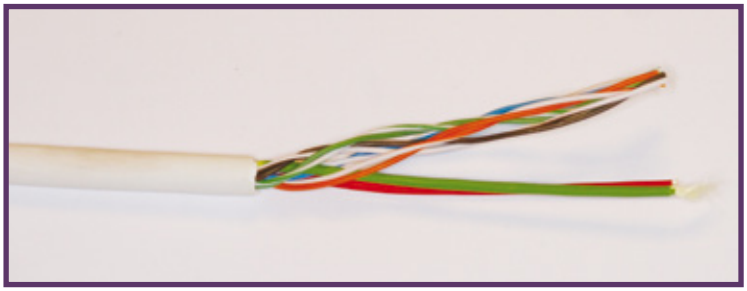
Fiber in other countries

Fiber is laid out in many countries, using different kinds of installation materials. The following pages show pictures of fiber installations from all over the world. The pictures are not representative in all cases, but not manipulated in any way.

Fiber in Greenland

Fiber that is laid out in Greenland, is used by Tele Greenland for communications. TG provides for fiber connections between public buildings and companies, that want these connections. Greenland is one of those countries, which value their fiber cables and thus protect them with the so called half ducts, in which the cables are placed. They even bury much of the fiber. The result of this are installations, which are good and stable, but expensive too. The installations seen on the photos are from Nuuk, but the same method is used in most towns. Cables, cabinets and enclosures must be able to withstand the low temperatures in Greenland.

Figure 9



Hybrid cable, consisting af 4 copper pairs and two fiber tubes.

All communication in Greenland takes place by means of radio chains. At smaller distances, however, these chains are furnished with fiber.

Figure 10

Commu-nication to others

Figure 11

All fibers are protected by means of half ducts, consisting of iron pipes, protecting the cables against external influ-ences.

Figure 12

At major installations you will see a lot of cables and ducts. Here you see tele communication lines from the main telephone exchange of Tele Greenland.

Figur 13

Half ducts are laid out where needed.

In the beginning of 2009, Tele Greenland will bring into use an undersea fiber cable from Canada. A total distance of nearly 3000 km. The cable comes ashore at Nuuk in Greenland. From here a cable is being laid to Iceland. The cable to Canada has a capacity of 960Gbit (not bad for a population of 48.000 people) .It uses DWDM, with 96 10Gbit channels.

Fiber in Iceland

Fiber is installed in a large scale in Iceland, but the work is not so demanding, as most people live in the same city. The local power plant carries out the fiber work, so the power plant now offers a wide range of services; electricity, cold and hot water and internet access. Everything is buried in the ground and there must be no visible signs of installations on the customer's building facades. These demands are challenging for the planning and design of installations. In Denmark we normally mount a little box on the building facade, but in USA you will see huge boxes.

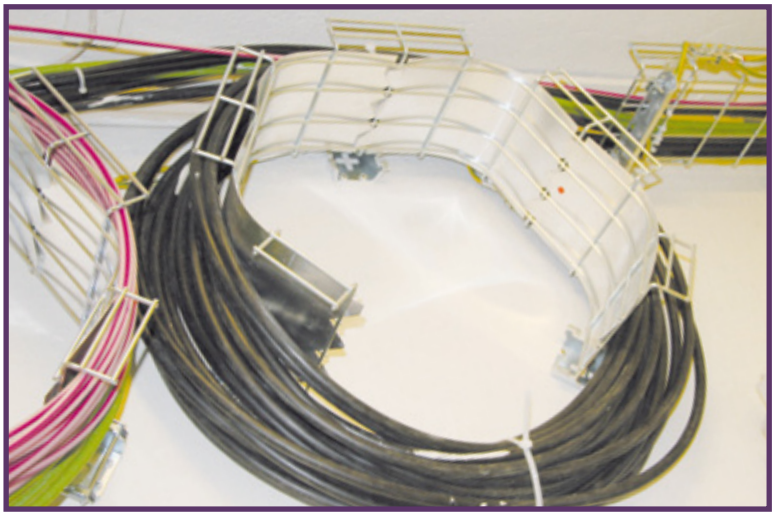
In Iceland they have chosen a point-to-point structure, based on fiber, and an IPTV solution. This makes the installation easy to carry out, with good test and troubleshooting opportunities, and of course a high speed internet connection is an option for everyone.

It will take some years before they have finished the installations, and for the present many summer cottages are being built. The summer cottages will become connected as well. The internet connection to the outside world is extensive, so most people do not have a flat rate connection. Many cafés offer free wireless internet, so you can check your mail, even being on holiday. Maintenance checks, repairs or new installations may be difficult to perform, as all installations are made as hidden installations. In addition to this, pavements and some of the roads are heated, making accessibility to fiber cable installations even more complicated. The backbone network consists of cables. Micro fiber cables, with a width of just a few millimeters, are blown into a 10 mm tube. Close to the customer fibers are blown into 5 mm tubes.

Figure 14

A small ODF

Figure 15



Handling of cable surplus

Figure 16

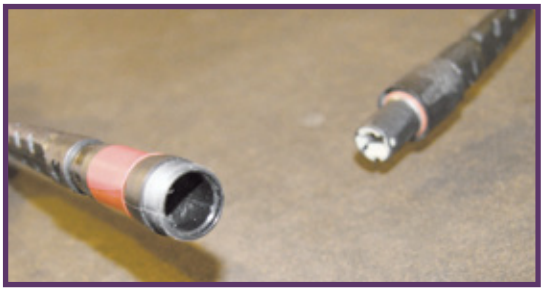
Installing a manhole

Fiber in USA

In USA it is almost always PON (Passive Optical Network) that is installed and the big provider is Verizon. As opposed to us in Denmark, when talking about connected houses, Americans mostly talk about houses they have passed. The conditions in USA are different from those in Denmark, as the distances between the individual houses frequently are longer in the countryside. 50 km between houses is not unusual and consequently, the budgets will have quite another significance, with regard to fiber as well as finances. When installation work is done, it is not done in quite the same way as in Denmark. In Denmark we use skilled workers (in most cases), but in USA they use workers having only a little training, or no training at all. As a consequence of this, they have developed plug systems everyone can use. Corning has developed a new type of encapsulation for the protection of conventional connectors, called hardened connectors.

A hardened connector is a really well protected SC connector.

Figure 17



A hardened connector

Figure 18

Quadruple outlet for hardened connectors

Figure 19

An enclosure bottem equipped with hard-ened connectors

In USA they do not have the same tradition of placing cables in the ground, as in Denmark. Instead, lots is hung up on poles. Looking at the many fancy one-family neighbourhoods in USA, you will soon notice the poles in the back gardens. On these poles you will find high and low-tension wires, copper based cable tv and, at last, optical fiber connections. Everything on the same pole. Not all poles are standing in an upright position, due to the weight of all these installations.

Installations are done as PON installations and it has become clear, that inter-net consumption is increasing intensely. The increase is, to a less extent, caused by traffic from net servers to users, it is rather caused by an increased internet traffic between users.

That is, in stead of client server solutions, they set up point-to-point solutions, leading to a massive increase in consumption of bandwidth. GPON is gaining ground, successfully, and the first couple of millions of consumers have been passed. However, measured as a percentage of the potential number of consum-ers, this figure is not that big.

Regarding installation reliability, we only know, that electrical installations in USA are not allways so stable as one could expect or hope for. If you apply this ascertainment to fiber installations, they may not be reliable as well. Neverthe-less, they install a lot on fiber.

Figure 20

Enclosures mounted on a pole

Figure 21

Distribution cabinet

Figure 22

Copper CATV plus fiber

Figure 23

Cable surplus is also placed in the pole

Figure 24

Not a pretty sight

Fiber in Korea

Korea has also, to a great extent, chosen fiber as the best solution and consumers are connected massively. Like the Americans, Korea has chosen the PON structure. The standard is 100 Mbit to all users. Korea is one of the countries in the world that produces many CPE's (Customer Premesis Equipment), which is the equipment, located at the customer's premises.

You may say that the Koreans are at the forefront, with regard to this area of fiber technology. The strategy in Korea is to deliver fiber to as many people as possible. The Koreans have chosen the ariel solution, with all installations mounted on poles.

Korean and American fiber installations look virtually identical – they may work, but it is not a pretty sight.

Figure 25

Figure 26

Figure 27

Fiber in Japan

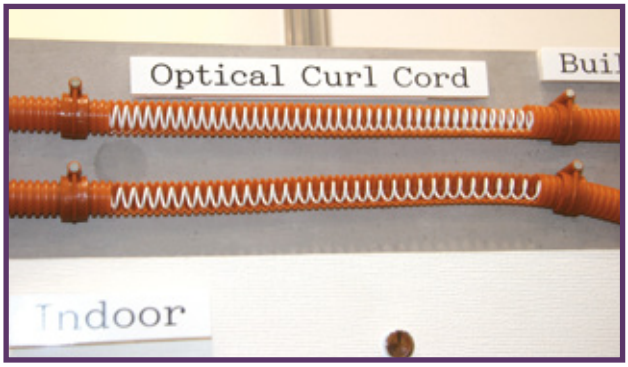
Japan has chosen the PON solution too. The big supplier of tele/optical fiber communi-cations in Japan is NTT (eqiuvalent to Tele Denmark Communications in Denmark - TDC)

As opposed to TDC in Denmark(with regard to roll out FTTH), NTT has a great influence over the installation of fiber in Japan, as NTT is actually setting the standards.

NTT also takes part in the developing of new equipment and installation techniques. For the present, 100.000 customers per month are connected, which seems impressive, but compared with a population of 127 million inhabitants, there is still a long way to go.

The Japanese tell gladly, that they have more than 100.000 films to chose from on their video on demand system. But who is really interested in watching so many japanese films - besides from the Japanese themselves?

Figure 28



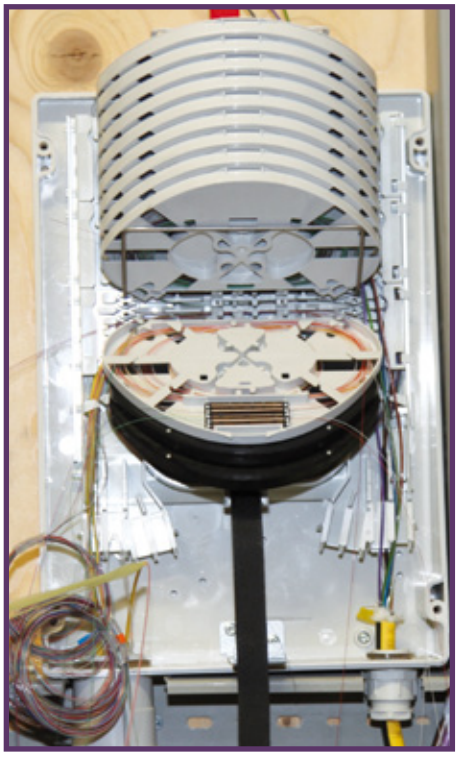
Fiber spiral, invented by NTT

Figure 28 shows a photo of a new type of optical fiber, developed by NTT. The fibers are spiral twisted and can be pulled into a 16 mm tube. The spiral is compressed by a factor of 1:20 and one meter of spiral can therefore be pulled out in a tube up to 20 meters. Very ingenious, but only time will show, if this invention will gain popularity.

Fiber optics in Holland

In Amsterdam, the FTTH roll out has also begun. The underground is all ready filled with cables, ducts and so on for other purposes, so there is not much room left. Local regulations state that, there may not be any visible ducts or cables, this means everything must be put into the ground. Manholes or hand holes are too big, so enclosures are buried directly into the ground. POPs or distribution houses, are not aloud to be erected, this is due to the fact that as the population density is so high, there is not enough room. This means that existing rooms have to be used.

Figure 29



This picture shows a feeder cable coming into an apartment building(MDU), an being split up into the different apartments, yellow cable on the right bottom is the feeder cable, fiber on the right is to the apartments

Figure 30

The fiber are in this case joined with mechanical splices. Here we see a mechanical splicer from Tyco

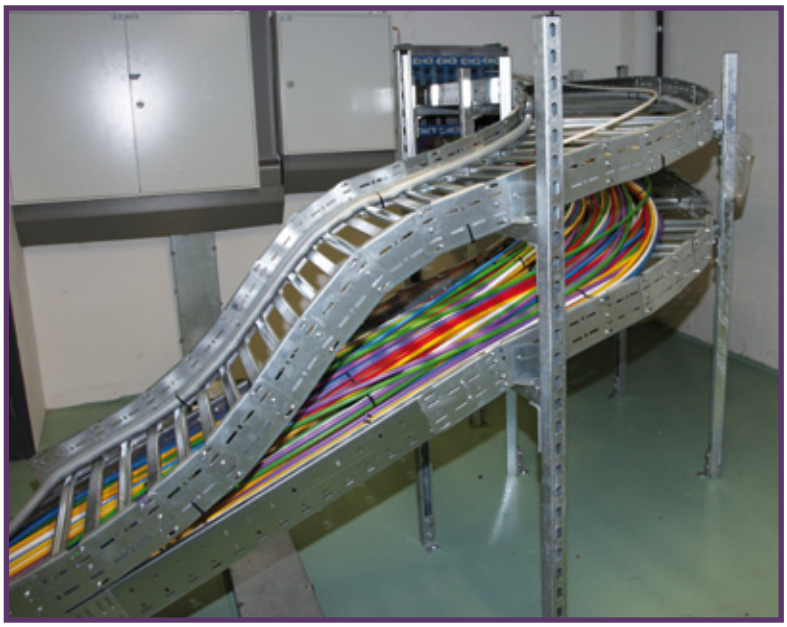
Figure 31

Here we see a distribution room for several thousand customers, placed in the basement of a building

Figure 32

Going into the room demanded that everybody had antistatic shoes

Figure 33

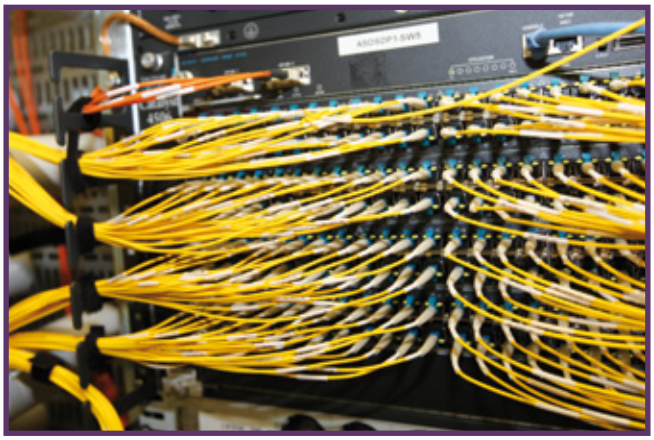


Here we see the ducts com- ing from the outer side of the building, going through fire stop- ping blockers

Figure 34

An ODF containing patch cords which connect the switches with the customer cables

Figure 35

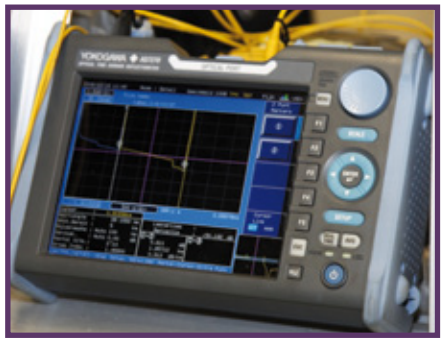


Here is the other end of the patch cords, mounted in the switch. This is a point to point installation

Figure 36

Here is the analog TV part, notice that all the connecters are green (reflection free)

Figure 37



Under instal-lation all fibers are measured with an OTDR

Fiber in the Future

It is allways difficult to predict the future. But there are strong indications of a constantly rising need for data communication. All forecasts point out a continuing, unchanged growth. And this growth never seems to stop. The first PCs were born with a speed of 4,77 MHz and now you see speeds of more than 4 GHz – that is, 1000 times faster. The first modems could handle 110bps, but faster modems were soon required and the standard dial-up modems ended up with a transmission range of 56Kbs. The ISDN system followed the 56Kbs modem, but ISDN became soon obsolete and was substituted by ADSL, having a speed of 20Mbs. The supplying companies (in Denmark) now offer 50Mbit up – and download speeds, but 40Gbit networks are being established.

The 100Gbit standard is in preparation, and will probably be marketed before the begining of 2009. A new fiber type has recently seen the light of the day – the bendbright xs (from Draka) fiber. This fiber is able to withstand bending down to under 7,5 mm diameter, an improvement of the exsisting limit of 60 mm. New fiber types are introduced, solving tasks, arising all the time. A good bet for the nearest future might be:

- A 10Gbit internet connection to all homes.

Then we shall have enough bandwidth for all our needs.
A DVD player is not needed, as we can watch films online on the net.
We do not need photo albums or media containing films. Everything can be seen on the net, at all times.
We do not need to have that many books, as we can do our reading online (yet, nothing usable is available at the moment).
We shall not settle for an obsolete HD ready tv. Successors of higher quality are on their way.
3D tv will be introduced. There are ongoing tests with this type of tv
Our screens will get much bigger, will weigh less, become more flexible and will be much cheaper than today.
Digital photo frames (allready available).
Digital live picture/video frames (also available).
We shall get communication possibilities with live video transmissions from all kinds of places, between TVs, mobile phones and fixed-line network phones.

But it all requires an infrastructure based on fiber which means:

- A fiber connection to all homes.
- A fiber connection to all companies.
- Fiber connections to different kinds of registering units or, in other words, to places, where something is being measured, controlled, regulated etc.

Yet, it is a necessity, that everything is properly installed and done professionally, in accordance with the rules of good craftsmanship. The manufacturers' instructions must be followed at all times, and all installations must be well documented.

Why Do We Need All That Bandwidth?

It is still difficult to get a high speed internet connection installed. Allthough the electric companies (in Denmark) lay out a lot of fiber, a long time will pass before everybody has access.

The tele companies, supplying the ADSL connections, keep on telling people, that 4 or 8Mbit is more than sufficient, but if you are dependent on internet, 50 Mbit is preferable.

Another problem concerning the ADSL suppliers, is that the delivered upload speed is to low, to be of any use. The speeds are as low as 128Kbit, 256Kbit or 512Kbit as the highest possible.

If we look at the development of our consumption pattern, we will notice, that the pattern has changed. Earlier we had 80% LAN traffic and 20% WAN traffic. The better part of our programs/files was placed on our computer at home, or on the company's computer at work. Today the traffic has reversed, 20% is local traffic and 80% is WAN traffic. As the network card nowadays is 1Gbit, the hook-up to the internet should be 10Gbit.

How do we make use of the bandwidth?

Mail: The consumption is not that big. For most people, the transmitted data is way below 1Mbyte per day.

Public Sector: Now accessible day and night, 365 days a year. You do not have to queue anymore, as many of the matters can be handled over the internet. Easy, quick and convenient.

Health Care: Much information concerning health care matters are available on the net. In some cases, it is possible to access medical charts, and if you have a digital signature, you may check your status within the public health insurance.

Tickets: If you need train tickets, tickets for the cinema or a flight, it is possible to book on the net.

Games: It has become common to play games on the net. The games keep getting bigger, and thus there is a rising need for more capacity.

Banking: You may be let off to go to the local post office or bank, when you have bills to pay or money to transfer. All you need, is to connect to a homebanking system on the net.

IPTV/Web TV: A stream of information is transmitted through the IP connection, it uses a lot of bandwidth. If you are recieving standard quality, the cost is a few Mbit. If you, on the other hand, recieve HDTV, every tv channel will use just under 20Mbit. And if you have 4 or 5 tv sets in the house (which is quite common, nowadays), the necessary bandwidth will be almost 100Mbit. www.joost.com

Surveillance and Protection: This is an area that will grow intensely, and consequently it will take a huge amount of bandwidth. In the future, private houses, office buildings, streets and alleys will be monitored and secured.

Communication: The communication we have with one another is getting more and more influential. Communication in this respect means information we exchange with other people over the internet, webcam transmissions of HD quality for example. You are able to experience events, although you are not there, physically. In that way you can monitor your house, although you are not at home.

Hospitals: It will be possible to monitor patients in their homes. The doctors' time can be planned more efficiently, and maybe patients will be let off some transportation between different regions of a country. Undoubtfully, there will be a need for live operations so that doctors, world wide, can watch operations in selected hospitals.

Monitoring: Electricity, water and gas. It is possible, continually, to monitor the consumption of these resources, and if an unusual rise suddenly occurs, you may contact or alert the consumer.

As it appears, there are multiple opportunities – and new ones turn up daily.

The website **www.youtube.com** is a good example of a large-scale consumer of the internet. Compared to the total traffic on the internet some years ago, the traffic from this website alone is significantly heavier today. At the moment, **www.youtube.com** is considering upgrading, so that any film you watch on youtube will be of HD quality. This upgrade will make massive demands on their storage capacity, but the demands on bandwidth on the net will be even more massive – an increase of 16 to 40 times. Imagine yourself uploading a film clip of 1Gbyte or a full DVD disc. With a 56Kbit modem this upload will take four days, but with a 1Gbit connection, the upload will be reduced to a couple of minutes.

In USA there is great concern, if the internet backbone will be able to keep up with the high speeds, offered by FTTH. They are concerned, in particular, that the development and people's consumption of internet services will be slowed down