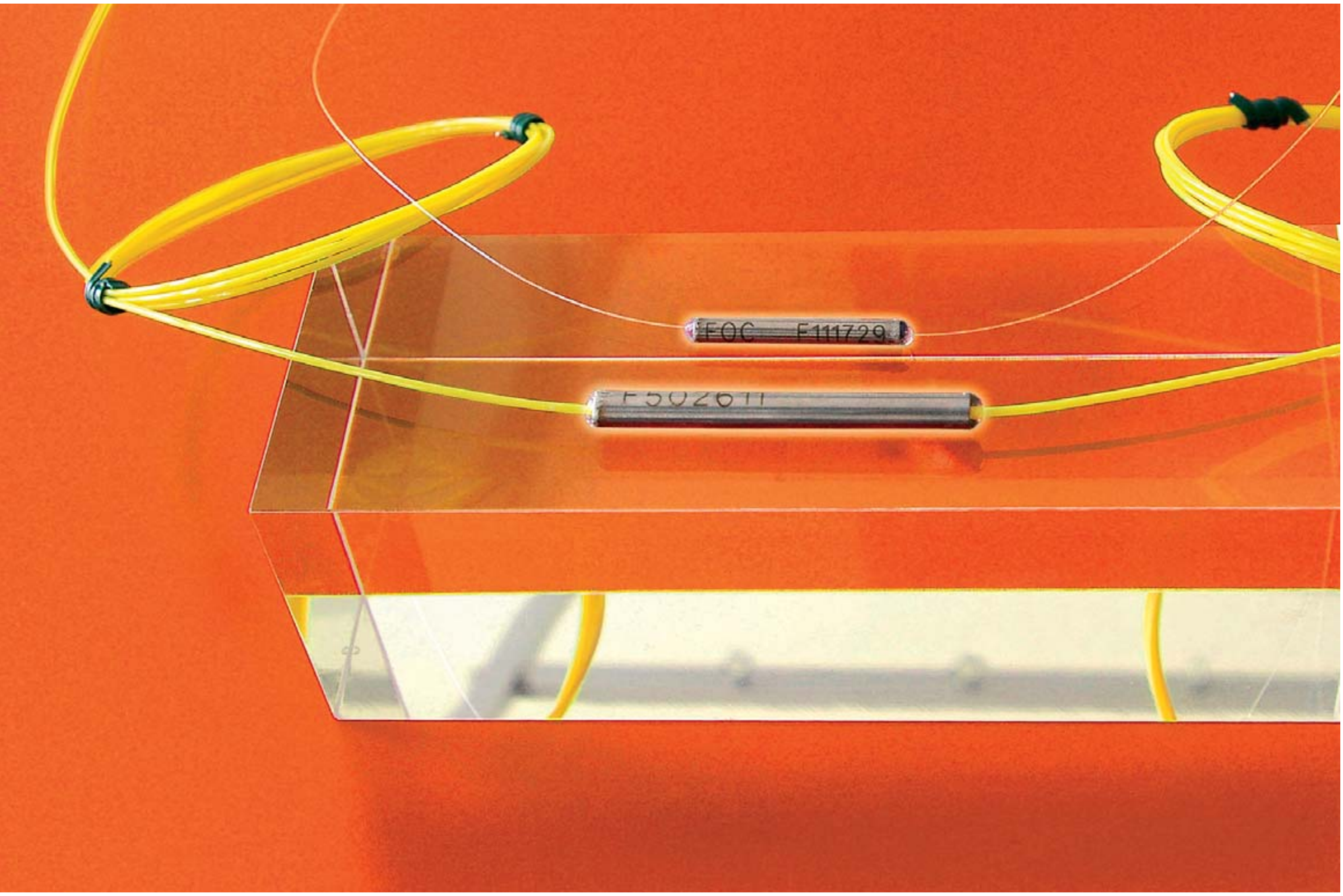
fibre optical components GmbH

At the speed of light into the future



foc

flash-light

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Editorial

photo: Stephanie Eißrig

Je breitbandiger die Anwendungen im Wireless-Bereich werden, umso kürzer wird der Abstand zwischen dem mobilen Endgerät und der Antennenstation. Wenn wir wirklich breitbandig werden wollen, führt an der Glasfaser kein Weg vorbei." Dieser einfache physikalische Zusammenhang, von Herrn Klaus Petermann, Professor für Hochfrequenztechnik an der Technischen Universität Berlin, auf den Startpunkt gebracht, zeigt klar das nachhaltige Mittel gegen die weißen Flecken bei der Breitbandversorgung in Deutschland. Wo wir heute stehen, ist dem Breitbandatlas 2009 des Bundesministeriums für Wirtschaft zu entnehmen. Hier werden die FTTH / FTTx Anschlüsse unter der Rubrik sonstige Anschlüsse geführt. Welch ein Potential! Gerade im scheinbar unwirtschaftlich zu erschließenden ländlichen Raum besteht Bedarf von Kundenseite und Ideenreichtum. Hier haben neue Lösungen von KMU eine gute Chance zur Realisierung. Ein innovativer Kreislauf von neuen Netzkomponenten, Installationstechnologien, Aus- und Weiterbildung, Energieeffizienz und neuen Wegen zur medizinischen Betreuung beginnt sich zu bewegen. Wir freuen uns über das „Tauwetter" zur Beseitigung der weißen Flecken und möchten Ihnen in unserer neuen Ausgabe über einige Schritte auf diesem Weg berichten.

Christian Kutza, General Manager

»Broadband Republic« of Germany

quo vadis?

Benefits and obstacles of deregulation

In market-oriented systems competition is deemed to be the most important coordination principle. In this way the Monopoly Commission considered the principles on which the regulatory and competition policies are based to be liberty, efficiency, democracy and constitutional state as well as prosperity and peace.

Although even in the past there was a broad political consensus in the EU countries on the benefits of competition in general, the telecommunications sector was structured in the form of a state monopoly for more than six decades. The secure provision of operating telecommunication services was considered to be that essential for the national economies, that their organisation almost naturally was placed into the hands of the respective state, in order to exclude the risk of a possible market failure right from the beginning.

In Germany this fact was even protected by the constitution until 1994.

Moreover, for the telecom market so-called universal services were defined, which had to be provided by the state company. The telephone service, for example, was such a universal service.

Currently we can see the failure of the market in the provision of broadband access in Germany, in particular in suburban areas. Before the deregulation the state authorities were able to command the provision of such infrastructures. Currently however, the comprehensive supply of the population is difficult, because no cost-efficiently working company will invest in rural regions without attaining an ROI of at least 4% in 1 to 5 years and a recovery period of max. 10 years. It has been proven that due to the lower population density per square kilometre this is more difficult to achieve in rural areas than in urban regions.

A state-owned or communal company could extend the period to 15 or 20 years.

However, if broadband access would be a universal service, the communal companies could fulfil this task using public money.

That this is a dilemma has been recognised by many already. After all, the "going public" move of the biggest German state company "Deutsche Bahn" has been postponed several times for good cause. A short-term income and an instable ROI development surely were only one side of the coin. The other side is the unlimited assurance of an operational transport system in a functioning national economy and the development of prices and thus the required secure provision of investments into the future infrastructure (railway lines, stations, cargo…). Currently this does not really function well in the already deregulated telecom market.

Conclusion: Competition always leads to falling prices. This may be compensated (without economic crisis) by growth (new services). However, the new services and thus also the revenues will be created by other parties. Monopolies prevent competition, but might be used as a social safeguarding instrument (stable prices) and thus for secure revenues to be used for reinvestment purposes.

The network operator's dilemma

Recently is has become more and more difficult to achieve cost-covering revenues on the residential customer telecom market. After the implementation of flat rates in particular in Germany no network operator has achieved a sufficient profit margin in order to invest in the new access network infrastructure, i. e. in optical fibres, which will be required in the near future. This is most evident taking the example of the "telephone" universal service (see Fig. 1).

So far the copper TP business based on leasing lines from Deutsche Telekom without investing in the passive network infrastructure has been a relative rewarding business case (see Fig. 2).

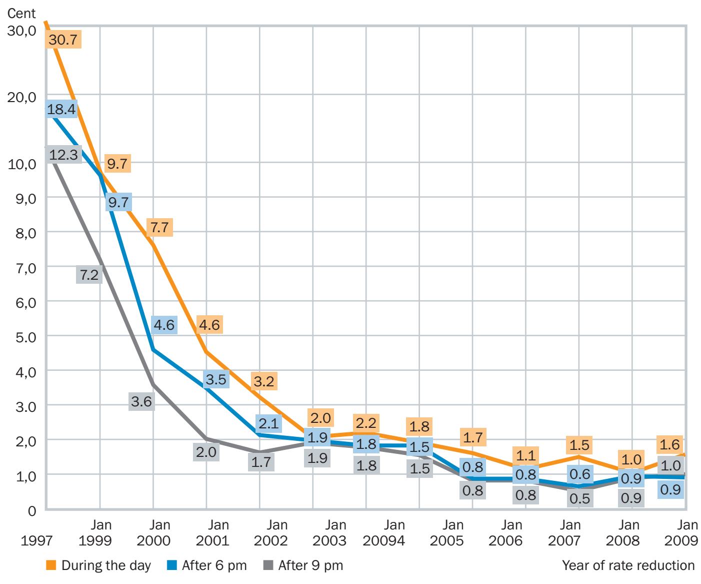


Fig. 1 Development of minute rates over the past 12 years (Source: German Federal Network Agency)

But Deutsche Telekom, too, explores unorthodox ideas. So the company blatantly announced to be considering a "scrap bonus" for analogue telephone connections on a technical conference in Dresden in mid-June - another way to get hold of necessary investments for new infrastructures.

Telephone connections/additions of the alternative subscriber network operators

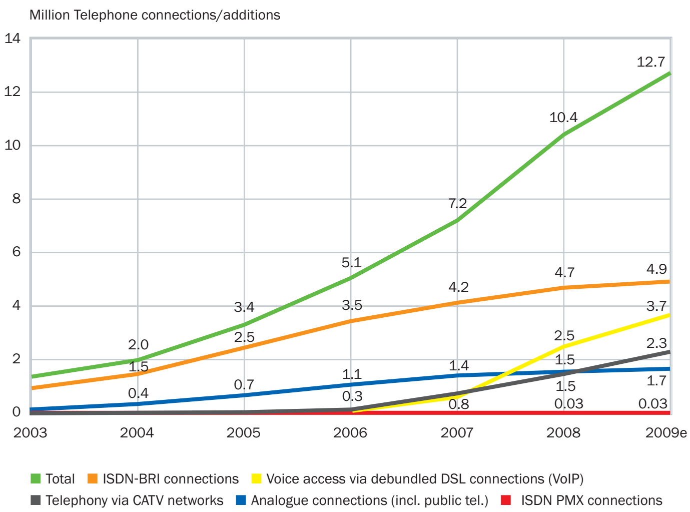


Fig. 2 Pre-selection and debundled access to the subscriber line of DTAG (Source: German Federal Network Agency)

In this case only the active terminal equipment (from the ISDN NT to the DSL modem) would have to be replaced. However, no market participant, not even DTAG, currently has these new fibre-optic infrastructures available all over the country.

But the new fibre-optic infrastructure, preferably up to the subscriber, is needed. Investors increasingly select the locations on the basis of available broadband access. Currently upload rates of 1 to 10 Mbit/s are hardly of any use for residential customers. What is the use of a self-produced HD home video, if it takes two hours to upload it to a server?

Flat rates are counterproductive to network infrastructure expansion.

Consequently this new fibre-optic access network needs to be newly installed. The expensive aspect is that in Germany the fibre-optic cables have to be buried in the ground - not only in urban areas. Other countries and their metropolises are better off in this respect, because they use above-ground aerial cables, as they did before with their copper lines.

So, if the network operators hardly profit from the increasing broadband capacity of the networks, who is? Currently the powerful service providers such as Google or YouTube seem to profit most from the situation. They use the open broadband IP platforms of the network operators and thus can always offer new and innovative services such as video-on-demand (VoD) or IPTV. Thus the open access demanded by so many has become a reality already (Fig. 3).

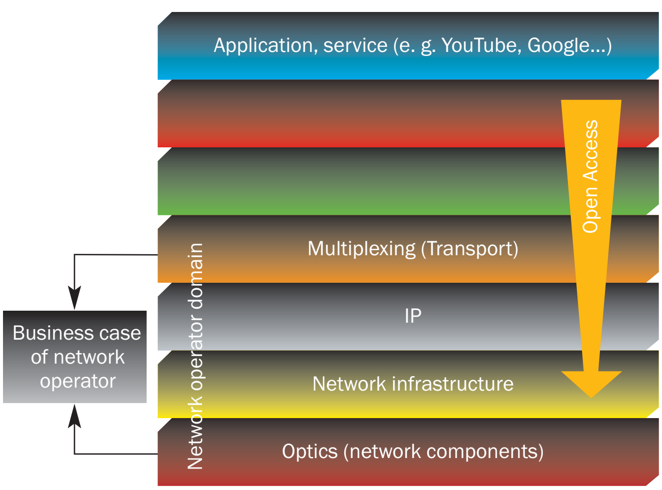


Fig. 3 The network operator's dilemma: low profit margins in the core business (Source: FOC GmbH)

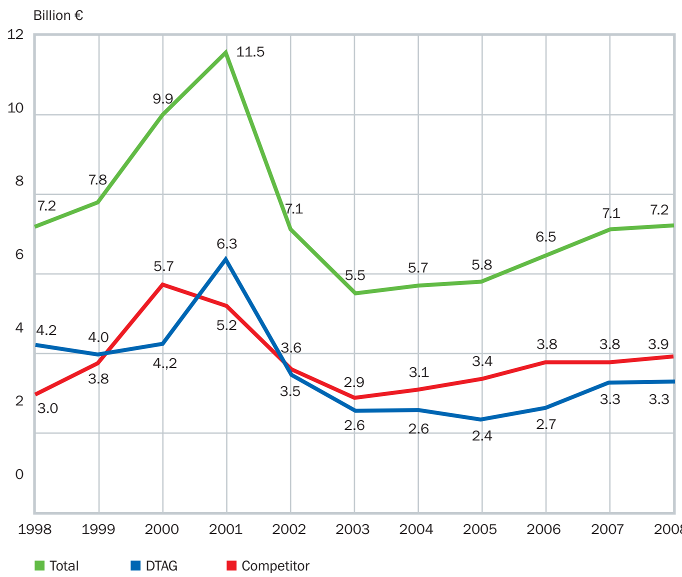


Fig. 4 Development of investments made in the German telecom market over the past 12 years
(Source: German Federal Network Agency)

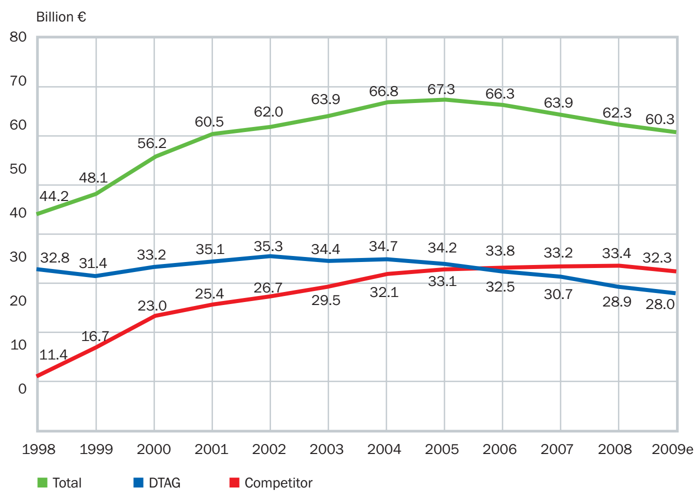


Fig. 5 Sales development on the German telecom market over the past 12 years (Source: German Federal Network Agency)

The trap has snapped shut: flat rates have proven to be counterproductive to the required expansion of the network infrastructure. New revenue sources for financing the required investments are not available (see Figs. 4 and 5).

Here the state has a considerable share in the blame for this situation because of its regulation policy. After all, without competition there would be no flat rates, since they would not be necessary in order to survive in a competitive environment.

Now the question arises: What to do now? What will be the task of the state in this context? Where shall the money for the required new infrastructure in the access network come from?

A uniform, coordinated strategy for providing future broadband infrastructures (definition: symmetrical <100 Mbit/s) is needed in order to prevent investments in the wrong direction (digital dividend = mobile radio as a replacement for broadband fixed network) and to use the money in an efficient and coordinated manner.

There are already some positive examples available.

Other countries have found different solutions: In Australia, for instance, the state has launched a gigantic economic stimulus package to the amount of 43 thousand million Australian Dollar.

Thus 90% of the Australian population shall be provided with symmetrical fibre-optic connections of 100 Mbit/s over the next 10 years. But this is not the end of the story. A new company (NBNCo = National Broadband Network) with 1,500 employees ensures the implementation, planning and marketing of the new network under state supervision (http://www.nbnco.com.au/).

Well, 43 thousand million EUR would not be sufficient in Germany to achieve this aim. But such a sum is better than the currently available 250 million Euro which aim at providing the population in rural areas with broadband access of at least 1 Mbit/s in the downstream (is that broadband?).

Here, too, the digital dividend of 1 Gbit/s per wireless tower in future does not help. Because wireless is and will always be a shared transport medium. In this specific case, with a total coverage of 20 km. The practical implementation will show how many users have to share the 1 Gbit/s. But with 10 users already the capacity limit of today's GPON system is reached, to say nothing of the upstream.

We are looking forward to a thrilling development on this market. We will all get enough to do …the question is: When?

Tilo Kühnel, sales FOC GmbH

Mankind and technicians need reliable standards and values

When two humans talks with one another, two preconditions must be fulfilled:

1. They must speak the same language.

2. They must know what they are talking about.

In the engineering field understanding is ensured by mean of definitions, standards and values.

On this basis we can make sure that the technical equipment will function within the overall system.

All this also applies to the telecommunications field and to their transport media, i. e. the networks, which today mostly consist of optical fibres. In order to interconnect sub-networks and to create network gateways there are optical connection technologies available for permanent and temporary connections.

Optical connectors, and this is what we are talking about, are temporary connections. Their connecting interfaces, parameters and properties are defined in international standards just as measurement techniques, tests and inspections for their characterization.

Thus the IEC61755 standards series among other things defines the insertion loss (IL) classes for the optical connectors.

Neither in this series nor in any other standard a "0.1dB class" has been defined yet. The reason for the absence of such a Grade A which actually should be defined analogue to IEC 61755 is the fact, that the representatives of the different connector technologies have not yet managed to agree on a uniform approach, uniform parameters and limits for defining a Grade A.

Eventually the definition of a "0.1dB class" or "premium class", to mention just two examples of possible descriptions, always is vendor-specific and not "standardized". Thus it is not possible to make a reliable statement regarding the loss values when mating connectors based on different connector technologies.

However, this is just what the customer, i. e. the network operator, is interested in.

The compatibility of different manufacturing technologies and materials must be defined and stipulated in a standard. If connec-tors do not meet the requirements of this standard, they are not compatible for the purpose of this standard.

Consequently, currently for a combination of full-ceramic and two-component ferrules only a higher loss (IEC Grade B, IL ≥0.25dB) is standardized resulting in a limited guarantee of the transmission parameters. But it is very well possible to produce

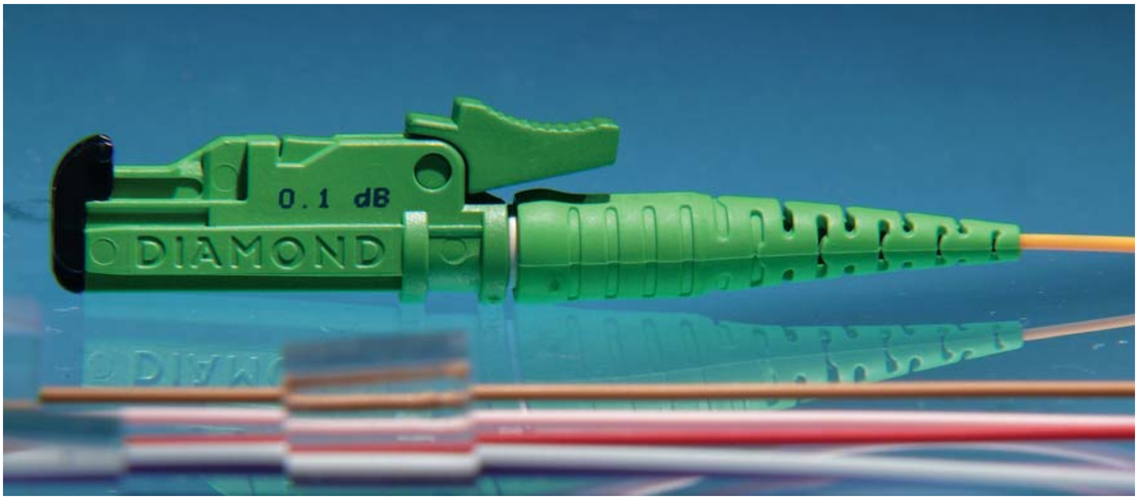
FOC guarantees standard compliance

mono-block connectors which are fully 0.1dB compatible with 0.1dB connectors based on a two-component ferrule technology. Preconditions are tight manufacturing tolerances, coordinated glueing and polishing processes etc. But there will be more details on this in one of our next editions…

For all loss classes according to IEC61755 compliance with the maximum loss value of a class depends among other things from the compliance with the geometric parameters of the connector surface.

There are no such limits defined for other influencing factors:

· For the polishing angle there is no standard available defining the acceptable angle! However, its tolerance affects the acceptable tilt angle.
· The deviation between different measurement systems, which thus directly occur when measuring the tilt angle and eccentricity, cannot be taken into consideration. Here, there will always be a certain tolerance required.
· The not strain-free curing of the glue during assembly or flawed crimpings for strain-relieving the connector might result in microbendings in the fibre. Depending on the wavelength these factors will differently affect the insertion loss of the connector.



Thus adhering to the geometric limits defined for tilt angle (<0.4°) and eccentricity (<0.125 µm), according to the model provided in the IEC 61755 series, offers the chance of manufacturing 0.1dB quality independent of the connector technology used.

Consequently compliance with these two limit values is required, but not sufficient, since there a further factors influencing the loss values and thus the quality of the mated connection:

1. Impacts / measurement impressions on the connector surface.
2. Scratches on the connector surface.
3. Deviating polishing angles, in particular with APC connectors.
4. Apex offset.
5. The contact force in the fibre core area.
6. Deviation between the measurement systems used for determining tilt angle and eccentricity.
7. The wavelength - the assembly process may lead to wavelength-dependent losses, e. g. caused by microbendings.

Of course you might argue, that for some of these parameters there are limit values and standards available, which naturally should be adhered to. But all these limit values are just for such impacts, measurement impressions, scratches, apex offsets and parameters, which define the contact force.

Thus there are influencing factors for which there are no standard-complying possibilities available to ignore them while "complying with all standards" during the manufacture of "0.1dB quality".

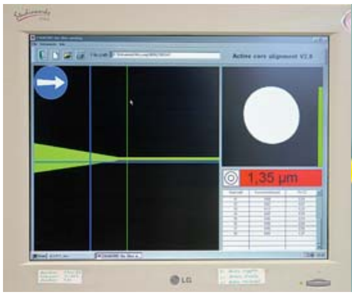
Eventually the aim of the customer can only be to receive proof of the loss values obtained, just as is the case with other "standardised" loss classes. This can only be done by ensuring that the supplied connectors comply with their limit values in comparison with reference connectors. The respective proof can only be demonstrated to the customer via "0.1dB" marks, measuring tags, sticking labels or measurement value tables.

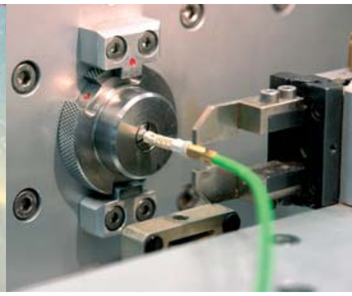
But tilt angle and eccentricity, as suggested by some competitors, are no sufficient proof of the delivery of "0.1dB connectors".

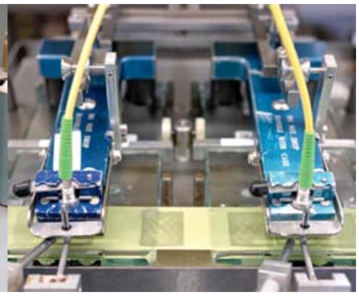
If, in future, the measurement tag with the loss values indicated should be missing on your ordered "0.1 dB" patchcord or pigtail, I can give you the following advice: Back to sender - because the supplier either does not adhere to the standard or cannot proof standard-compliance.

And a last word: You should stipulate in your specifications that you want to have your products delivered with a measurement report.

Advantages of the »0.1dB technology«







0.1dB-technology – our contribution to Green IT

1. Technology basis

The core alignment procedure reliably compensates for fibre geometry fluctuations so that the core of the fibre always is in the ferrule centre.

Fibre strain during the curing process is minimised and a clearly reduced wavelength dependency of the insertion loss is achieved by the stress-free curing process when fixing the fibre (1h, 70°C, 3h 100°C) into place.

The combination of selected materials with an optimized grinding process ensures that the fibre is always the highest point of the connector. This systematic elimination of fibre undercut, which is a typical risk of connectors based on one-piece “monoblock” ferrules, guarantees, that the fibres of the connectors always have physical contact with sufficient contact force.

The grinding process, which is optimized for the highest possible radius of the endfaces, facilitates a higher reproducibility of the contact force while minimizing the risk of fibre damage (caused by a partially excessive contact pressure). In particular in combination with connectors from different manufacturers the higher endface radius will lead to a higher compatibility than can be found for connectors with a low endface radius.

2. Reference character

Due to core alignment and squint-angle tuning all connectors which are based on the compound ferrules made by Diamond SA, are virtually equivalent to reference connectors according to EN 50377.

Thus the reproducibility of the launch conditions and the measurement results when mating with any other connector (also from different manufacturers) is better than when mating connectors from different manufacturers not using the advantages of core alignment. The measurement results for core-aligned connectors are always directly comparable with the measurement results from the pre-shipment inspection of the delivered patchcords / pigtails of any supplier.

If connectors with monoblock ferrules are used, the assemblers use connectors, for which the tuning procedure will be used for loss-optimisation, if they are loss-optimized, at all. Depending on the supplier and on the quality of the assembly kit and of the fibre, inconsistencies between the measurement values in installed condition and the values from the supplier’s pre-shipment inspection may occur. Since every manufacturer is virtually compatible with itself only, the mixed used of patchcords from different manufacturers will result in a larger deviation of the loss values and thus in a higher operational risk.

3. Loss budget

Through the use of core-aligned connectors reproducible insertion loss values of ≤ 0.1dB can be achieved. Using connectors with monoblock ferrules this optimum value can only be attained by thoroughly selecting the connectorized patchcords or by using cost-intensive connector assembly kits.

Optical links contain a multitude of mated optical connections. The consistent use of core-aligned connectors with an insertion loss of ≤ 0.1dB instead of, for instance, IEC Grade B connectors (≤ 0.25dB), eases the pressure on the link’s loss budget, and the resulting system margin makes the links future-proof and less sensitive to external disturbances affecting the cable connections and plants.

4. Repair instead of replacement as a contribution to environmental protection

Patchcords, in particular, wear out very fast. The optical surfaces are damaged during patching by mechanical shock, impressed dust and other contaminants.

As a result the insertion loss values frequently rise, backscattering attenuation sinks, the mated connections are less and less reproducible and more and more instable, and the mating connectors are damaged.

Unlike patchcords based on monoblock connectors, which, if damaged, have to be disposed of, the connectors based on Diamond compound ferrules frequently can be re-polished at least once. On the one hand the re-polishing is a clearly less expensive solution than a new patchcord, on the other hand it clearly improves the environmental footprint of the company.

Dipl. Ing. Axel Thiel
Head of Development Department FOC GmbH

FOC in Stuttgart

Economy, IT and Optical Fibres Side by Side

photo: © town Stuttgart

Baden-Wurttemberg is quite ahead of the rest of the federal republic in terms of the settlement density of industrial - in particular IT - companies, but also in terms of the future-oriented promotion of the broadband expansion supported by the government of this federal German state. And we at FOC now have expanded our distribution office for the south and the west of Germany there, in order to be able to accompany our local customers still better into the future of broadband technology and fibre-optical networks.

In Stuttgart FOC offers quite a comprehensive service. In our branch office we provide our customers not only with individual consultation but also with sample parts on site: Many of our products - system components and housing versions - are physically available for you to feel and touch. Moreover we are able to design our own specific housing versions in hardware and software and to present them vividly in the form of 3D displays.

And there is another asset making our attractive business premises particularly valuable for our local partners: A modern conference room for events and consultations and for providing high-quality support to our Workshop Talks series.

Research and development in IT technology are given priority in the southwest of Germany. The IT business, in particular in Stuttgart, is of considerable importance for Germany as a whole. Three of the biggest IT companies are resident in the Stuttgart area: IBM, Alcatel Lucent and - just outside the city limits in Boeblingen - Hewlett-Packard. They alone employ about 35,000 people.

With a share of about 30% in the value creation of this federal state the Stuttgart region is the driver for economic development in the state - and its organisational centre. But the regions of Upper Swabia, the Swabian Alb and for instance the Black Forest, which are rather unfavourable in terms of traffic and media technology, are also part of this state.

"The location is strong, because it was always weak," this is how Christoph Muenzer, Managing Director of the Association of Industrial Enterprises in Baden (WVIB) describes the economic status of the Black Forest region to the Handelsblatt journal. This paradox diagnosis is generally applicable: It was specifically the smaller enterprises in the federal state of Baden-Wurttemberg which suffered more under the disadvantages of the location - in particular under the high labour cost (even at a national scale) and the insufficient investment in the traffic infrastructure - than the large corporate groups in the big cities.

Here the Baden-Wurttemberg government has achieved quite a lot over the past decades and specifically over the past two years by systematically developing the infrastructure. Its broadband study from the last year, which particularly describes the support given to businessmen in the rural areas, has shown that you cannot be internationally competitive without having bandwidths of more than 50 MB in the coming years. And the government has acted accordingly and actively promoted public aid for broadband expansion in close cooperation with the local communities also in the "province". They have recognised that also for the companies in the rural areas the question is not whether to use the Internet or a "narrow bandwidth highway" or not. The decisive point is rather the quality of the network access line needed for national and international market presence in order to stay competitive and to be able to act productively.

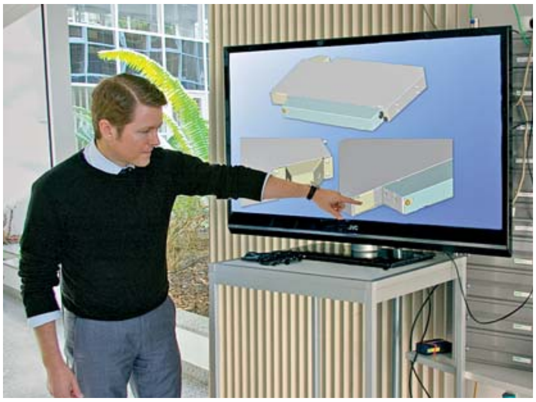
They have found out that over the past years the need for broadband has clearly increased across all industries and that another strong increase in the required bit rates is to be expected. In addition to the locational advantages of the rural area, including a higher quality of life for the employees and a better/less expensive availability of appropriate premises and buildings, which

In Germany's southwest historical "weak points" become "strong points"

should not be underestimated, the insufficient availability of sustainable broadband access as one of the serious locational disadvantages should absolutely be corrected.

Consequently the state has invested, in particular also acquired EU funds in Brussels, and allocated them directly to the expansion of broadband access in disadvantaged regions. Nowhere else in Germany high bit rate bandwidth is distributed and developed as evenly across the state as in Baden-Wurttemberg - and FOC has a crucial share in this development from its Stuttgart location.

Even some farms on the Swabian Alb now have access to a secure fibre-optic network. Over the coming months these networks will be intensively expanded, e. g. by connecting the many future LTE mobile towers to the fibre-optic network. These



towers are an intermediate step on the way to directly connecting the subscribers and shall continue to advance into the deep valleys of the Black Forest providing higher bit rates.

FOC is promoting this trend! From Stuttgart we support quite a number of customers from the fields of energy supply and research, from municipal utility works, and among other things also many system service providers up to handicraft enterprises, which have committed themselves to fibre-optic technology.

Contact us: FOC-fibre optical components GmbH, South-West Region, Zettachring 10a, 70567 Stuttgart, Germany, Phone +49 711 / 74 51 91 90.

Christoph Pauselius

R·KOM

Optical Fibres in Eastern Bavaria

Communication at the Speed of Light

The example of this local network operator in the city of Regensburg shows that advanced fibre-optic networks are deployed also in less densely populated regions. In 10 years 70% of the households shall have fibre-optic access. In the course of network expansion the network designers also test new reflectors made by FOC enabling the design of more efficient service models thus contributing to OPEX reduction in the long-term.

R-KOM was founded more than 10 years ago with the aim of introducing an alternative, cost-efficient and sustainable telecommunications offer into the market.

Initially the R-KOM offer was targeted exclusively at business customers. High-quality products (dedicated connections, IP networks, Internet and telephony services) were marketed at an adequate price.

Since 2004 we have expanded our geographic business area in order to increase our customer base. Meanwhile R-KOM has a number of metropolitan area networks (MAN) in Eastern Bavaria which are interconnected to form a regional network.

After competitors concentrated on intensifying the use of feeder distribution interfaces (FDI), R-KOM decided to enter the residential customer market and thus the mass market.

In order to ensure our long-term success we are installing the FTTx technology.

In preparation, together with the MAN operators from Rosenheim and Ulm, the Society for Innovative Telecom Services G-FIT was founded (which among others things also operates a softswitch) in spring 2007. G-FIT offers its shareholders and other carriers voice products on the basis of TDM, MGCP and SIP.

On the road to GPON (Gigabit Passive Optical Network)

Active equipment

Fundamental decision on the technology to be used

Prior to asking the manufacturers for their bids, we explored which technology would be most appropriate for R-KOM. For this purpose we compared Ethernet solutions in ring and star topologies with GPON.

Energy and maintenance costs are optimised in the GPON network.

R-KOM's decision in favour of GPON is mainly based on the following reasons:

- R-KOM requires an access network in order to provide a large number of customers cost-efficiently with TV (RF overlay), Internet and voice services.
- RF overlay and GPON have identical network topologies considerably simplifying construction, operation and documentation.
- Moreover the network is OPEX optimized. In this context we mainly analysed energy and maintenance costs.

Requesting bids for active equipment

The request for bids concentrated on the features of all components which were detailed in compliance lists. Items of particular importance for R-KOM were additionally emphasized.

In the price section specific scenarios with quantity structures for the next years were required. This provided the bidders with a precise basis of calculation enabling the determination of appropriate and realistic prices. Meanwhile other carriers have joined the contracts we have signed with the manufacturer.

The contract for active equipment was awarded to Alcatel-Lucent. Fig. 1 illustrates the solution.

The GPON NMS (5520 AMS) or the provisioning system exclusively communicates with the OLT (Optical Line Termination, central element). This OLT manages all downstream ONTs (Optical Network Termination, terminals at the customer's site) via the OMCI (ONT Management Control Interface). There is no need for the user to deal with the assignment of GEM ports or other system-specific settings. Thus the provisioning system can be kept relatively simple.

For R-KOM this clear architecture played a vital role in its decision in favour of the Alcatel-Lucent solution.

The VDSL modems are provisioned via the TR-069 Server HDM (Home Device Manager), which communicate via XML with the R-KOM provisioning system.

Open Access

R-KOM believes that Open Access, i. e. the use of services by third-party carriers, is an important factor fuelling the success of FTTx. On order to finance a comprehensive fibre-optic development, a market penetration of at least 30% in the developed areas within a period of 1 to 2 years is required. This will only be possible to achieve by opening the services for other carriers.

A dedicated data base is developed for Open Access allowing third-party carriers to check online the development status of the customer's location and to automatically provision the offered services.

Fig. 2 shows a schematic of the DP environment.

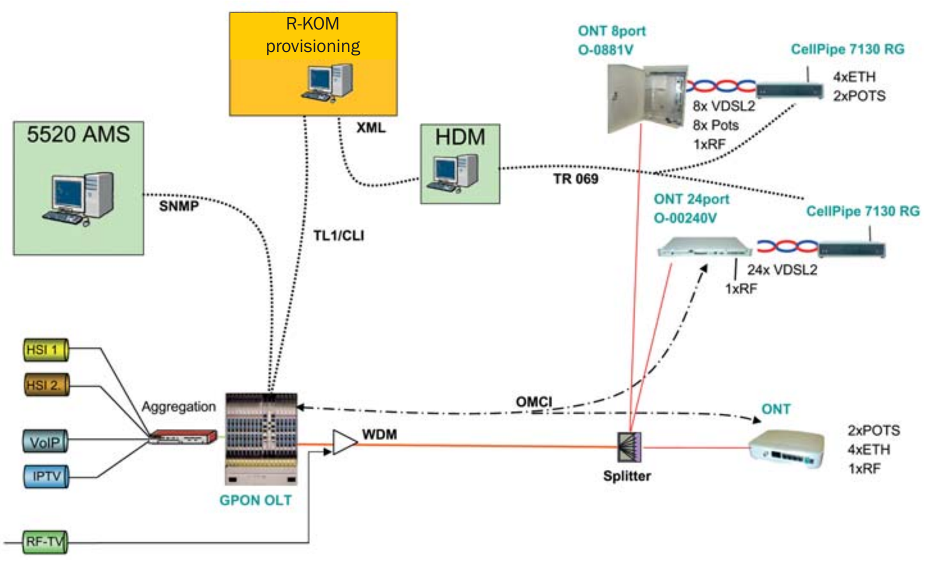


Fig. 1 Schematic of the GPON solution

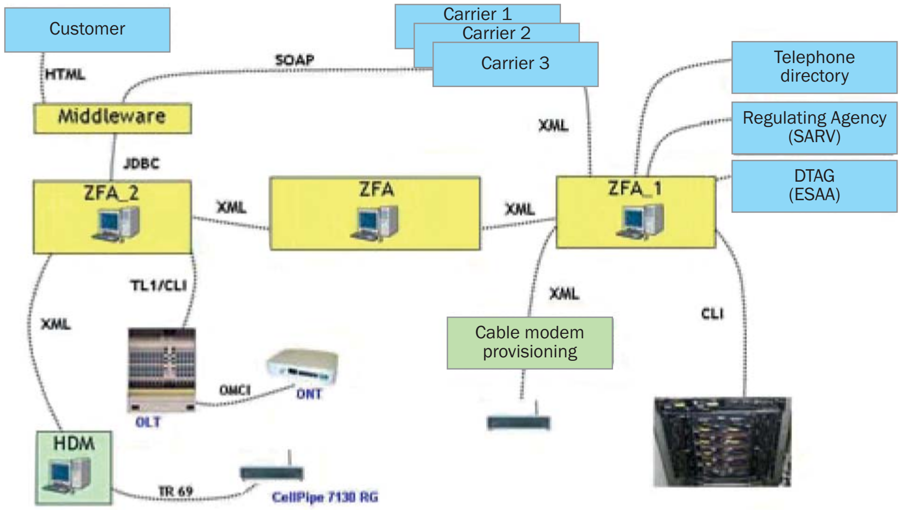


Fig. 2 Schematic of the DP enviroment

The backbone nodes

Four backbone nodes will be installed in Regensburg and one to two backbone nodes in the smaller cities. The OLTs reside in the backbone nodes. All downstream nodes are equipped with passive components only. At R-KOM each rack contains one OLT and the associated TV amplifiers. The WDMs for multiplexing the TV and GPON signals are already integrated into the amplifiers. This saves one patched interconnection in the TV branch, relieves the link budget and eliminates one source of defect.

Since all components have a mounting depth of just 300 mm, the racks can be equipped from both sides ensuring the efficient use of the rooms.

In the cabinet an additional FO cable management had to be designed, since the manufacturers of the active components do not offer such solutions yet, although the number of optical interfaces per subrack is continually increasing.

Passive equipment

The expansion of the fibre-optic network

For several years R-KOM and/or the regional utility companies have been installing fibre-optic networks for connecting a manageable number of subscribers.

So far industrial property and service points such as Deutsche Telekom main distribution frames (MDF) and wireless locations have been connected via the network.

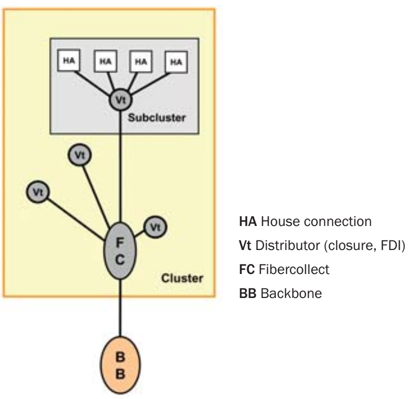


Fig. 3 Schematic of the topology of the passive network

The expansion was made using high-fibre count backbone cables in empty-conduit systems with limited capacity at cost-intensive distribution points for customer connections.

However, after deciding to connect also residential customers and thus a multiple of the existing number of customers, this type of connection had to be reviewed.

We needed to perform network planning with other tools and, in particular, more intensive than before. We had to ensure that sufficient capacity for the follow-up projects was made available with each construction measure. On the other hand we did not want to create excessive capacities, since this would increase the investment requirement, which was already high anyway.

Microtube systems proved to be the most economic solution for implementing the high number of outgoing sections in the R-KOM development area.

The requirements and basics were stipulated in a manual. This part of the project is as time-consuming as it is crucial.

Fig. 3 outlines the schematic structure of the passive network according to the manual.

For planning purposes the development area is subdivided into clusters first. An R-KOM cluster contains a maximum of 3000 housing units. All optical fibres of a cluster are terminated in one room, the Fiber Collector (FC).

A subcluster describes the service area of a fibre closure or of an FDI. It is defined by the maximum blow-length of the cable and by the maximum number of terminable tubes and/or fibres.

R-KOM decided in favour of an FO expansion which is independent of the active hardware, since the useful life of the passive network is much longer than that of the active equipment.

Here an overview of the key planning rules applied at R-KOM:

- For each housing unit one optical fibre is routed into the building. Additionally 2 fibres are terminated in the optical point of demarcation.
- Splitters are used only in FC rooms and with a splitting factor of 1:32.
- Cables directly routed to a Fiber Collector (FC) have a minimum number of 144 fibres.
- The maximum blow-length for microtube systems is limited to 350 m (7 mm tubes) and 700 m (14 mm tubes), respectively.
- The FC rooms are selected to house active equipment and utility services.

A graphic planning tool was introduced assisting in the selection of the clusters, the determination of the quantity structure and the routing of the cables.

Once a project is completed the associated data is transferred into the documentation systems of the utility companies.

In future the already integrated project management tool will be used for controlling the work.

The Fiber Collect (FC)

The cabinet for terminating the optical fibres from the backbone to the customers is the central element in the FC. This cabinet is an optical distribution frame (ODF) and available in several designs.

Additionally the splitters must be accommodated in the FC room. These can be installed in their own cabinet, in the ODF cassettes or as separate modules.

OPEX and CAPEX, but also attenuation and space requirements have to be taken into consideration when equipping the rooms.

A sufficient number of measuring and/or monitoring points in the form of mated connections needs to be provided for operation. However, these will adversely affect the link budget and the installation costs.

Fig. 2.4 gives an overview of the link attenuation scenarios.

As a minimum requirement it must be possible to measure the links from the BB node to the splitter, the splitter itself and the connecting line to the customer without breaking splices.

R-KOM decided to use a solution where splitter and pigtails are housed in a cabinet. The splitters with the spliced pigtails are installed in the top of the cabinet and can be connected to any customer port. Up to 1584 fibres are connected in a 900 mm wide cabinet.

The optical distributor in the FC room

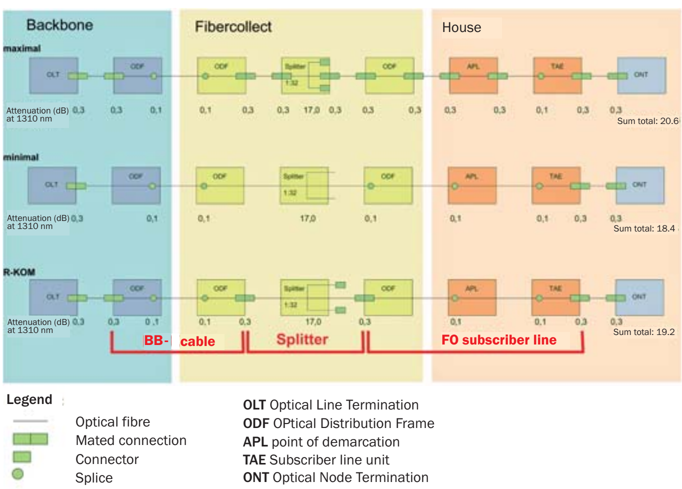


Fig. 4 Attenuation scenarios

The attenuation scenarios show that a maximum attenuation of about 19 dB occurs. GPON and TV overlay operate up to a system attenuation of 27 dB. With an attenuation margin of 3 dB, which should be provided to compensate for the ageing of the links, distances of about 17 km can easily be bridged. This is sufficient across the whole R-KOM service area.

In-house termination

In Germany, there usually is a service entrance equipment room in the house, where all utility lines are terminated. However, frequently the building connection point for TV or the point of demarcation (DTAG copper distributor) is installed in other parts of the cellar or even in the attic.

For FTTB R-KOM has decided to install the optical line termination as close as possible to the point of demarcation.

An analysis of the first comprehensive project shows that about € 800 for installation and material have to be earmarked for developing the coaxial and copper infrastructure in buildings.

Since many different designs of the points of demarcation are available, it is not possible to strictly standardise the connection. In particular in buildings with very many housing units freely accessible private points of demarcation having a very different quality are used. Partly the point of demarcation and the cables are laid under the surface. Contrary to the perception that outside cabling is not used in Germany, outside distributors can be found time and again. The worst case is a locked point of demarcation of DTAG, which must not be opened. This results in a mostly cost-intensive development of the house cabling after the point of demarcation.

The long-term aim is connecting all households via FTTH (Fiber to the Home). In order to determine the cost required for a fibre-optic house cabling we have completed a pilot project where 6 different manufacturers and installers replaced the coaxial cabling with optical fibres in identical houses containing 8 housing units each. The requirement was to perform the replacement within one working day as follows:

- Installation of the fibre-optic cabling from the R-KOM service entrance room in the house up to the first terminal unit (first TV socket).

For this purpose an access line had to be installed from the service entrance room to the conduit system beginning on the ground floor.

- Replacement of the TV socket by an optical socket providing two SC/APC connectors.
- Termination of the incoming 12-fibre cable using an optical demarcation point. One fibre was spliced through to each of the flats, two fibres had to be terminated on pigtails in the demarcation point on SC/APC.

The other fibres had to be stored in the demarcation point.

Care has to be taken to exclusively use bend-insensitive optical fibres according to ITU-T G.657A.

All teams managed to perform the conversion within one working day. Per housing unit costs of about € 180 for installation and passive terminations were incurred.

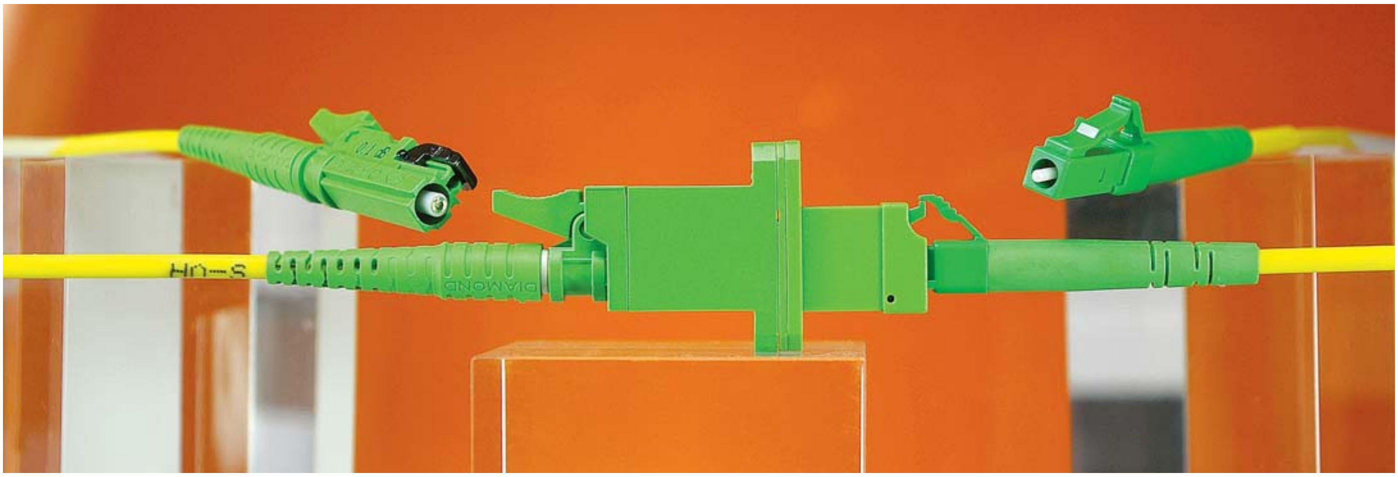
Taking the costs for hardware, operation and service into consideration and against the background of the current price structure a house cabling of up to six housing units per building is more economical using FTTH instead of FTTB.

Conclusion

For active equipment, R-KOM believes, automation of the operation is the key to success. This should be supported by high-performance and stable hardware with a clear architecture.

With FTTx we break new ground in particular with a view to passive equipment. Over the past year many new products have entered the market, because the manufacturers have recognized their chances. Prices for some components will fall considerably due to higher production volumes. Thus technically optimum solutions, which were discarded for economic reasons, could become interesting again within a short period of time.

Compatibility of different ferrule designs



Optical connectors are standardized both in terms of their interface (e. g E-2000, LC, SC …), their test conformity (optical, climatic and physical) and optical parameters (IL, RL…) and in terms of the geometric parameters of the connector surface.

- Fibre optic connecting interface compatibility (= physical mating compatibility) in the IEC61754 series
- Compatibility with a view to their operational behaviour (tests) in the IEC61753 series
- Compatibility with a view to their optical and geometric parameters in the IEC61755 series

Additionally the basic test and measurement procedures are standardised in the IEC61300 series.

None of these standards limits the selection of the ferrule material.

The compliance with the standardised parameters forms the basis of the compatibility between the fibre-optic connectors from different manufacturers and also the basis of the compatibility between connectors based on different ferrule designs and ferrule materials.

In order to ensure the latter compatibility the so-called Optcal Interface was introduced in 2004 and standardised in the IEC61755 series.

The optical compatibility between fibre-optic connectors based on different ferrule materials is achieved by complying with all parameters in the standards of the IEC61755 series dealing with the optical interfaces. Depending on the material composition selected by the manufacturer, different parameter areas are defined to ensure compatibility.

The decisive criteria are the fibre core position and the defined and repeatable contact force between the connectors. This compatibility is achieved by defining the acceptable value range for the parameters of the polishing radius, fibre protrusion, and fibre-core offset etc.

Depending on the material used different limit values apply for the individual parameters resulting from the different mechanical stability and thus deformability of the material.

Currently the following cylindrical ferrule designs are standardised:

DIN EN 61755-3-1
Fibre-optic connector optical interfaces – Part 3-1:
Optical interfaces, 2,5 mm and 1,25 mm diameter cylindrical full zirconia PC ferrule single mode fibre (IEC61755-3-1)

DIN EN 61755-3-2
Fibre-optic connector optical interfaces – Part 3-2:
Optical interfaces, 2,5 mm and 1,25 mm diameter cylindrical full zirconia PC ferrule for 8 degrees angled-PC single mode fibres (IEC61755-3-2)

DIN EN 61755-3-5
Fibre-optic connector optical interfaces – Part 3-5:
Optical interface - 2,5 mm and 1,25 mm diameter cylindrical PC composite ferrule using Cu-Ni-alloy as fibre surrounding material, single mode fibre (IEC61755-3-5)

DIN EN 61755-3-6
Fibre-optic connector optical interfaces – Part 3-6:
Optical interface - 2,5 mm and 1,25 mm diameter cylin-drical 8 degrees angled-PC composite ferrule using Cu-Ni-alloy as fibre surrounding material, single mode fibre (IEC61755-3-6)

DIN EN 61755-3-7
Fibre-optic connector optical interfaces – Part 3-7:
Optical interface, 2,5 mm and 1,25 mm diameter cylindrical PC composite ferrule using titanium as fibre surrounding material, single mode fibre (IEC61755-3-7)

DIN EN 61755-3-8
Fibre-optic connector optical interfaces – Part 3-8:
Optical interface, 2,5 mm and 1,25 mm diameter cylindrical 8 degrees angled-APC composite ferrule using titanium as fibre surrounding material, single mode fibre (IEC61755-3-8)

Dipl. Ing. Axel Thiel
Head of Development Department FOC GmbH

What information can be gathered from a single-ended backscatter measurement?

Today it is unimaginable to do without backscatter measurements for recording the properties of optical networks (e. g. loss and link lengths) as well as for isolating trouble spots in case of faults. The fact that the fibre link is characterized from only one end is generally accepted as an advantage, unlike e. g. a measurement of insertion loss, where both ends are involved in the measurement and have to be accessible.

However, this fundamental benefit of backscatter measurements is of limited effect since today, as a general rule, measurements from both sides are taken during network installation and maintenance. But why is such effort undertaken?

The classic single-ended backscatter test reaches its limits when determining the accurate loss of optical splices. If fibres with different mode field diameters are spliced, splice loss is clearly exaggerated in one direction, whereas in the opposite direction an amplification seems to occur („gainer“). The reason for this confusion is that by abruptly changing the mode field at the splice point not only a local loss is incurred, but the backscatter coefficient of the fibre is modified. Consequently the attenuation determined in the course of the backscatter measurement is inaccurate[1].

In order to exclude this source of error the measurement procedure in the corresponding standards[2] principally stipulates a bidirectional measurement for determining splice losses, with the actual insertion loss of a splice being calculated by averaging both results.

However, in the daily routine the bidirectional backscatter mea-surement involves a considerable effort: Either two field technicians are working in parallel on both ends of the link or a single field technician is measuring both directions one after the other resulting in considerable truck rolls between the different loca-tions. Another disadvantage is that the link loss cannot be derived directly from the measurement, but has to be determined from the overlay of both traces. So any excessive link loss will be detected only after a complete measurement and analysis cycle. In order to resolve the problem the field technician then has to go back to the affected link.

The current build out of FTTB and FTTH networks is an incentive to avoid bidirectional measurements, because access to one end of the link is in the subscriber’s house or flat. Service assignments at the final customer regularly entail high costs through repeated truck rolls, if the customer is not at home at the first attempt.

Is it possible to somehow overcome the above limitation of the single-ended backscatter measurement?

Using a trick can help to derive the complete information of a bidirectional backscatter measurement from just one end[3]: To do so, at the opposite end a mirror (reflector) is installed which reflects the arriving backscatter signal as fully as possible. This creates a second echo pulse propagating time-shifted through the fibre in the opposite direction. The scattered light caused by the echo “extends” the acquired backscatter trace. Here it is easy to understand that the events along this extension are mirrored in relation to the primary trace (Fig. 1). From the measurement trace the same parameters can be derived as from the bidirectional measurement. In particular the attenuation value, averaged from both sides and thus correct, can be determined. This measurement offers quite a number of other benefits over the classic backscatter measurement: Firstly, the correct loss values can be determined immediately after the measurement; secondly, dead zones are completely eliminated[4].

Wavelength-selective reflectors open up new possibilities for

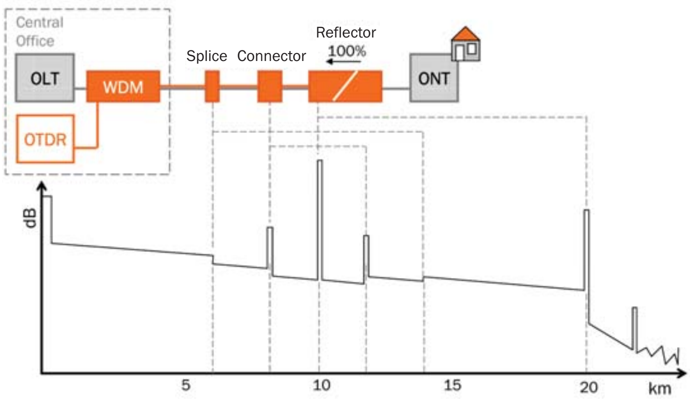


Fig. 1 Schematic of the backscatter trace on a 10 km long link with reflector at the end for exactly determining splice losses. The loss of a WDM was ignored in this example.

In another procedure for determining the link loss using a singleended measurement, reflectors are used, too. However, unlike with the classic backscatter measurement, the link loss is not determined by adding the individual loss values, but (after prior calibration) derived from the difference between the signal

1 »OTDR Gainers – What are they?«, Application Note von Corning Inc., July 2001
2 TIA-FOTP-61, ISO/IEC 11801 und EN 50173.
3 »Single-ended Bi-directional OTDR Measurements«, Application Note von Agilent Technologies Inc., April 2003
4 This is because the echo signal travels in opposite direction along the link. Due to this change in direction the dead zones will occur on the right side and on the left side of the event.
5 »Unidirectional absolute optical attenuation measurement with OTDR« Patent von Tyco Electronics, Pub. No. WO/2010/076567.

installing and maintaining fibre-optic links

levels of two reflectors installed at the start and at the end of the link. In this way it is for instance possible to precisely determine the loss values of partial links in PON structures without needing access to the subscriber port (Fig. 2).

Both outlined techniques are meant to illustrate by way of example which new possibilities for network maintenance are opened up with the use of reflectors.

However, what properties should a reflector have in order to be appropriate for the above mentioned application? A high reflectivity (near 100%) is important for the echo technique in order to obtain the highest possible signal level in the opposite direction. A second important factor is that the reflection must be wavelength-selective to ensure that only those wavelength ranges dedicated to service will be reflected. In this way the reflectors can be permanently installed in the network without affecting the flow of signals. As the next section shows, such permanent reflectors offer quite a number of other advantages.

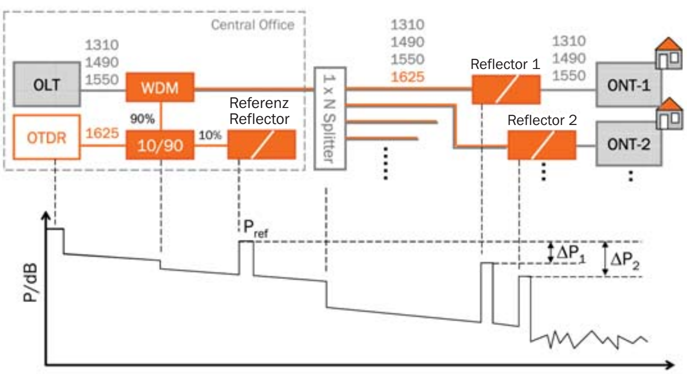


Fig. 3 Measuring the link loss of a PON network using a single-ended backscatter test. The loss value is calculated from comparing the signal levels of the reference reflector and the end reflectors.

When measuring the link length using the backscatter technique it is advantageous to have an end reflection so that the link end can be clearly distinguished from the noise level. For this purpose today the mated connection at one end of the fibre is simply opened, while measuring from the other end of the link. As with attenuation measurement, both ends of the fibre must be accessible here, too. A second disadvantage is that by opening the connector the flow of signals is interrupted for the subscriber: Consequently service work may only be performed during the contracted service hours, as a rule at night, which is a great burden for the service staff.

What network maintenance might look like in the future can be illustrated using the example of a FTTH PON architecture (Fig. 3). During the deployment of the network, reflectors are installed at each subscriber and as a reference in the central office (CO). In future, after the installation both the link length and the loss can be determined in-service any time from the CO without the subscriber even noticing it. In case of later modifications on a link (e.g. newly spliced partial sections during construction work) the link can be re-characterized with minimum test effort. If would even be possible to fully automate the testing process in the CO and to perform a remote maintenance of the network.

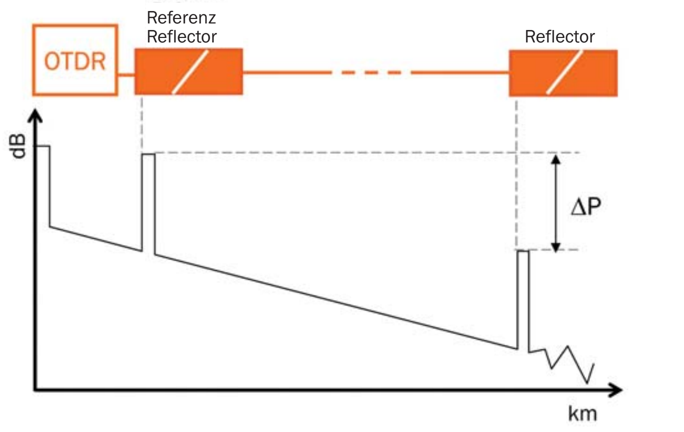


Fig. 2 The Reference technique calculates the link loss from the ΔP signal level difference.

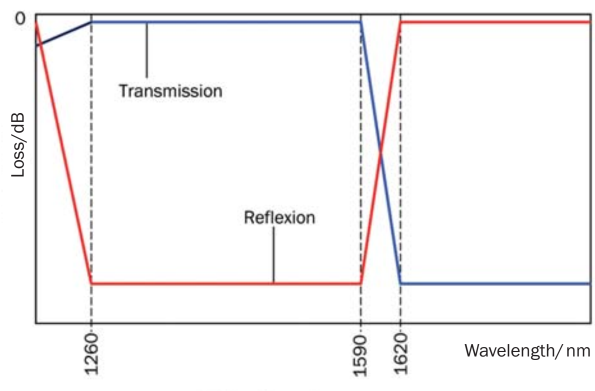


Fig. 4 The filter trace of the wavelength-selective reflector shows which wavelength portions are reflected and which portions pass through the reflector.

The examples mentioned provide a small insight into the multitude of new possibilities opened up by using wavelength-selective reflectors.

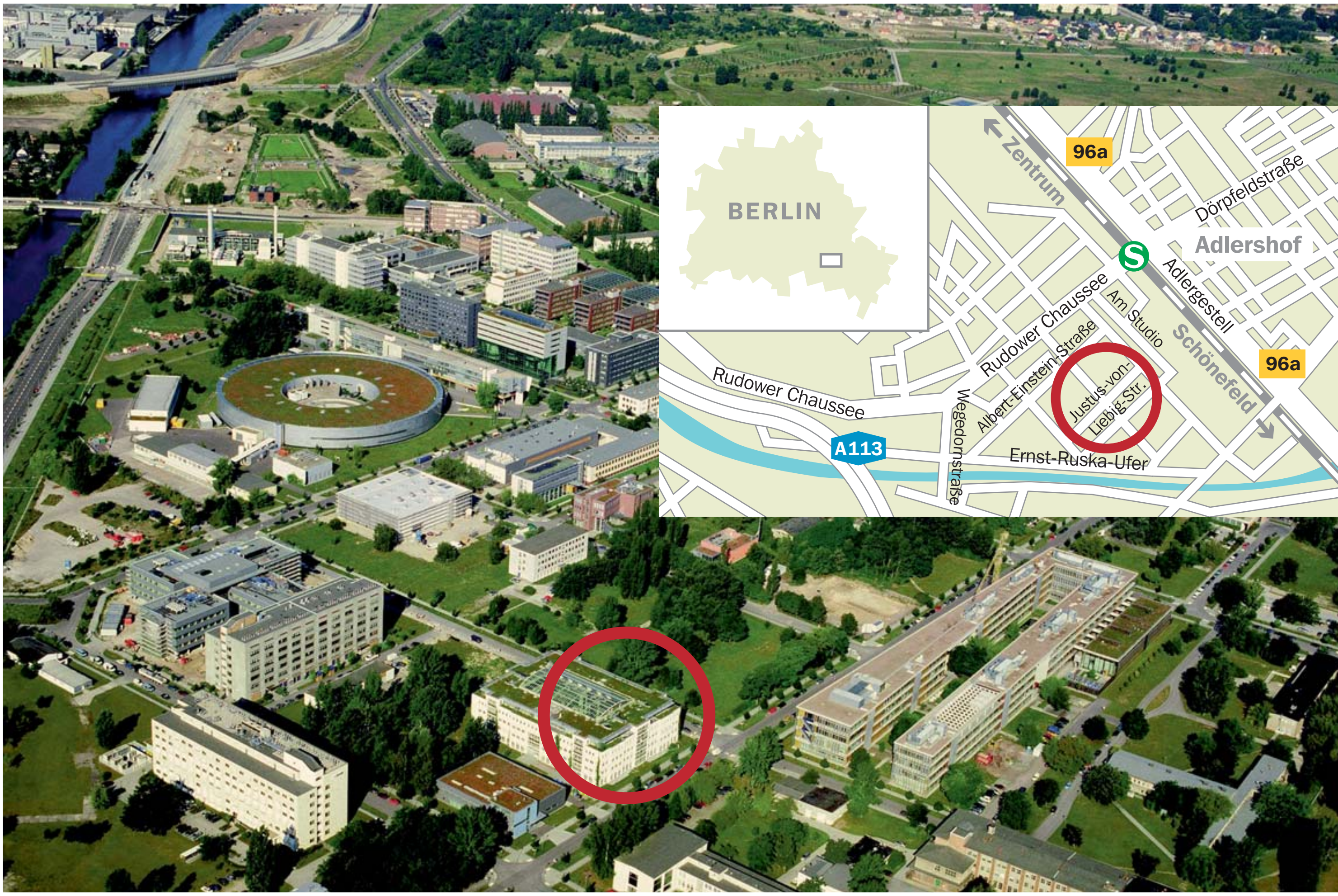
The specially designed reflectors from the new lili optix series with their low insertion loss in the signal wavelength range and their high reflectivity in the service wavelength range are the perfect solution for the above mentioned or similar applications. Their core is a thin-film filter (TFF), whose properties are outlined in Fig. 4. The filter edge is either at 1620 nm or at 1640 nm, depending on the service wavelength used by the customer.

Several fibre types and form factors are available ensuring the easy integration of the reflectors into existing housings. The pigtails can be fusion-spliced or terminated with any available connector standard. Custom packages are also available on request.

Dr. Martina Vitt
lili optix Product Manager

fibre optical components GmbH

In the Berlin-Adlershof Technology Park.



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