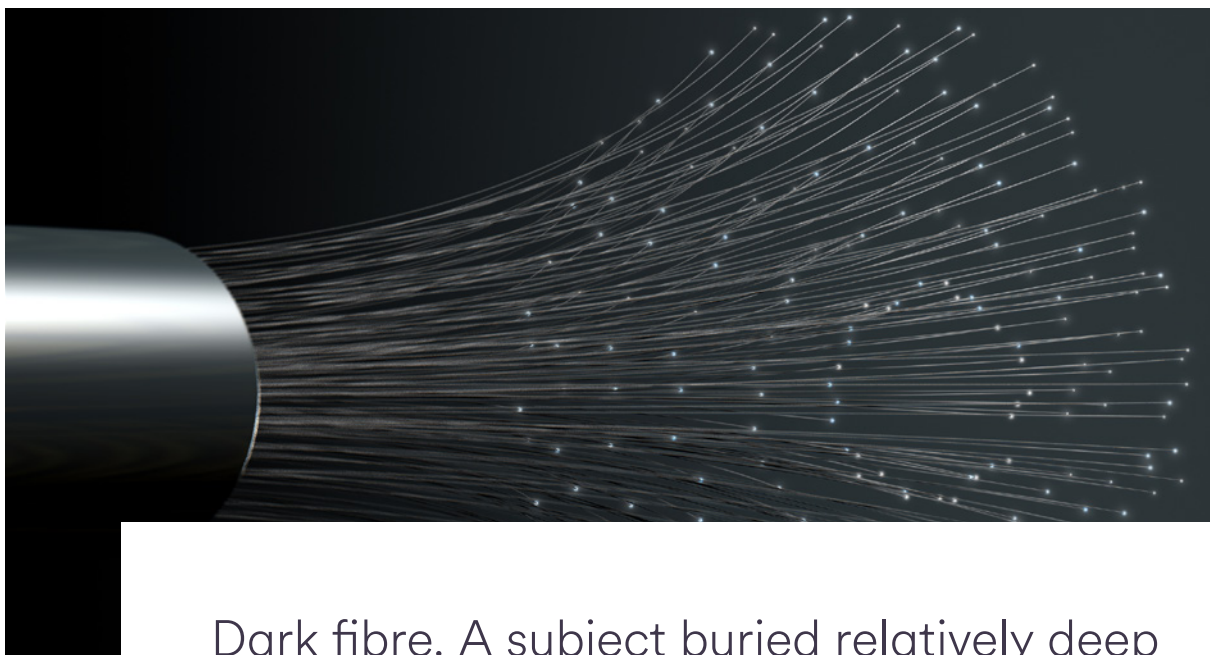


DARK FIBRE: WHY A CURSORY GLANCE WILL NEVER SUFFICE



Dark fibre. A subject buried relatively deep at the heart of telecoms and, by implication, digital business in general.

It's one of the final conceptual ideas most non-engineers can hope to discuss knowledgably. Peel back another layer and we're into subjects like Dense Wavelength Division Multiplexing. Which we think is utterly fascinating. But understand why others don't.

But because it is so close to that final, absolute engineering truth of telecoms, dark fibre is a complex subject. Take a cursory glance and you might misunderstand it entirely. Even those in or close to the telecoms industry are prone to draw conclusions which are open to challenge.

This paper is intended to open up its complexities in an accessible way. Which seems relevant given the recent interest following a burst of news coverage. So, if you're somewhat new to dark fibre, it's lovely to have captured your interest and we hope this serves as a comprehensive introduction.

But if you're already rather au fait, then we hope you'll take away a better understanding of our perspective on the market. But do feel free to skip forward to 'Why dark fibre?' on page five to avoid reading what you already know.

Either way, if you have decisions to make about dark fibre now or in the near future, we hope this paper informs and provides a useful additional perspective.

First, let's define our basic terms.

What is dark fibre?

Originally, it described the unused - or potential - network capacity of fibre optic networks. Without use – with no data shooting down network pipes in the form of pulses of light representing ones and noughts - telecoms fibre is unlit. Which led creative, yet somewhat literally-minded, engineers to coin the adjective 'dark'. Economically for the telecoms industry it was a bad thing – an overcapacity of supply not met by demand.

But meanings flex and multiply. And by the time Ofcom reviewed the market in 2016, it also referred to fibre network owners' leasing of fibre without providing a 'managed service'. Instead of supplying and maintaining the boxes which send the data down the pipes, it is possible to lease the 'dark fibre' only. Whoever leases it needs to do the rest.

The Swedish Post and Telecom Authority describes dark fibre as “the least refined service based on optical fibre” or a “raw network capacity” – physical cables without electronic equipment. It can be used to connect end users to various broadband services, co-located equipment in local exchanges, base stations for mobile telephony and other large, sophisticated networking users. Which makes it both very flexible and yet, being so close to the very essence of a network, very complex to deploy and maintain.

Why is dark fibre so relevant right now?

There's been a fierce battle in the UK over dark fibre in the last few years; a clash that has highlighted divided views on the usefulness of dark fibre in the telecoms market. It all began when Ofcom, the UK communications regulator, conducted its review into the competition for leased lines – something it has to do every three years. If it believes a provider has significant market power, it imposes regulations to protect customers.

In the 2016 Business Connectivity Review (BCMR), Ofcom concluded competition and innovation was not working in certain markets. And it required Openreach to make its fibre network open to competitors. Although, Openreach was already providing regulated access offering lit-fibre solutions (for example through EAD circuits), Ofcom also decided that the competition concerns in the market would be better addressed if a dark fibre product was available. Openreach was told to launch a Dark fibre Access product by October 2017.

According to BT's annual report, it would have provided competitors with “a dedicated, unmonitored, unlit optical fibre path between two sites up to 86km apart”. This would have been a game changer for the indirect market. However, it created a clash between those who strongly opposed it - including us at Virgin Media and BT itself - and those who backed the idea, including TalkTalk and Vodafone.

On the one side us telcos, who have been investing heavily into infrastructure for decades. We believed that the move would effectively erode our revenue, and prohibit our ability to upsell, cross-sell or layer the fibre with additional services. And therefore seriously hobble the commercial opportunity for further network investment. Which is something everyone agrees is unfinished work. To be more precise, Virgin Media Business said that the proposals sent “a negative message to investors in infrastructure and creates a very real risk of restricting the flow of funds to communications network investment in the UK”.

And, we added: “The intended imposition of a Dark Fibre Access (DFA) remedy will, in our view, serve only to undermine investment incentives and disrupt existing, competitive markets”.

Meanwhile, mobile network operators (MNOs) were content with the Ofcom ruling. It would have given them something slightly closer to network ownership and improved their economics, significantly so, in relation to very high capacity (>1Gb) circuits, which is particularly important when they're having to deal with seemingly endless demands for mobile data consumption and increasing costs for bandwidth.

However, in July 2017, the High Court's Competition Appeals Tribunal (CAT) said that Ofcom had wrongly defined the leased lines business and quashed the regulator's decisions.

So what's going to happen now?

Firstly, the regulator has to reconsider its proposals. And that means that any DFA product is unlikely to be available until next year at the earliest, if at all.

Some are expecting Ofcom to amend its market definition and re-impose DFA but it's unclear, at this stage, whether this will be possible or, if it is, what form a new DFA remedy would take. Not least because the full judgment from the CAT is unlikely to be released for maybe another month or two.

In the meantime, all of us interested parties – either for or against – have time to reflect on our own positions. Well, here goes. Let's start with getting to know the market a little better before we study the complexities of the product itself.

Who's interested in buying and selling dark fibre in the UK?

Buying

The need to use dark fibre has been driven by a demand for high-capacity services.

According to Ovum, this has stemmed from growth in the number and size of data centres requiring more connectivity between them, a growth in global commerce meaning more connectivity between businesses, and a growth of cloud-based IT services meaning more connectivity is required between businesses and data centres.

There are five major customer groups for high-capacity services: (i) communication providers and ISPs for core network connectivity; (ii) mobile service providers for backhaul and core network connectivity; (iii) data centre providers; (iv) enterprises that are highly dependent on communications services, such as those in the media and financial services industries; and (v) systems integrators who buy connectivity wholesale and bundle it into their complex packages of services and sell on to large corporates.

Providers of dark fibre include non-telco fibre owners, specific dark-fibre vendors and telcos that have dark fibre within their network. There are also two key variants of dark fibre: metro, for shorter distances, and long haul. In the metro environment, dark fibre is used as a substitute for lit services, whereas in the long-haul space, dark fibre is a standalone market.

On the metro variant, competition is high and in theory non-telco fibre owners can provide customers with fibre in its raw form, and not have to worry about customers wanting to upgrade to ethernet and dense wavelength division multiplexing (DWDM). DWDM is a development of dark fibre whereby multiple data signals are transmitted simultaneously over the same optical fibre, albeit at different wavelengths to keep the signals separate. The method is used to enable more data to be sent and to increase overall bandwidth. However, the cost of buying more fibre pairs is equivalent to or less than deploying multiplexing technologies to achieve the same capacity.

Regardless, non-telco fibre owners would still face a challenge in offering new routes, or competing with other high-capacity competitors on the same route, and in investing in connecting their backbone to the required locations.

Long haul, meanwhile, is better suited for service providers that need connectivity to distributed data centres, and core connectivity hubs, as well as firms building comprehensive private networks. But in both instances, the dark fibre customer needs to further invest in lighting the fibre. In the metro section, there is demand from a range of customer groups, whereas in long haul, telecoms service providers and internet service providers are the main interested parties.

Communication providers such as TalkTalk and SSE Telecoms had already made significant plans for the service that was scheduled to be available in October 2017. In theory, DFA gives these companies physical access to Openreach's fibre optic cables. They can then install their own equipment at either end, within BT exchanges and their own hub sites. The CAT decision will come as a blow to these Service Providers as DFA goes back to square one, or could potentially disappear completely.

Mobile service providers also want DFA to help them to increase their backhaul capacity, particularly as they move from 3G to 4G to 5G – their bandwidth continues to increase significantly, and demand is unlikely to slow down. Dark fibre is a cost-effective solution for these companies from a bandwidth perspective, as they don't pay on a bandwidth scale. They lease all the capacity and pay the same amount, regardless of how much (or little) it is used. What changes is the equipment on the ends and this they have full control of.

Dark fibre for data centre interconnectivity is more common in the US. According to Ovum, there is an increase in demand for both types of data centre connectivity – to and between data centres. It names New York-New Jersey, Washington DC and Northern Virginia, San Francisco and Silicon Valley as having “vibrant albeit quiet dark fibre markets”. Conversely, London is the largest of all data centre locations but only has a relatively small market because the market has developed in managed services products which achieve a similar goal without the technical implications of install and management for the provider. Which, in most instances, tends to be more efficient.

There are also enterprises or organisations that are highly dependent on communications services in the market. Financial services companies and banks turn to dark fibre for their need of speedy transactions and financial compliance. These transactions are often low bandwidth but immediate.

For a subset of financial services companies, there is a need for bandwidth-intensive core transactions including file sharing and transfers, business intelligence applications and data analysis. Considering the sensitivity around the data, and the need for no downtime for these organisations, they have a preference to be in control of their own network at a fundamental level.

Meanwhile, for educational institutes, dark fibre is a way to connect to the existing high-speed network, Janet, which is used by the UK research and education community. It is also a cost-effective way for universities to create a campus network for themselves connecting all of their buildings, and data centres.

Systems integrators may opt to use dark fibre to provide a managed data network, along with the offerings they're already providing their customers, such as retailing or networking services, as part of an overall managed service contract. However, these business partners often get better value by buying a data link or service from an infrastructure provider, rather than relying on dark fibre.

Selling

When it comes to selling dark fibre in the UK, the likes of BT, Virgin Media Business, City Fibre, EU Networks, Interoute, Level 3 and Zayo Group all have presence and capability.

And there are many other smaller companies that have the capability to offer a more limited DFA product.

Virgin Media Business currently offers dark fibre on a selective bespoke commercial basis. We see the value of our £16bn network investment paying back, predominantly, in the managed service business, whether that's in the Layer 1 optical level or Layer 2 ethernet-based products. However, there are cases where we offer dark fibre core to some larger operators, such as those in the cell site backhaul or exchange backhaul, where both parties agree that dark fibre has value.

In addition, there are several other companies who, in the future, could decide to sell dark fibre access. Reports last year suggested that Network Rail's trackside fibre, which carries transport, video and data communications, could be sold off or shared out through a wholesale or joint venture agreement – although there has not been any movement since. Network Rail had been granted 'code powers' from Ofcom to extend its national fibre optic network and offer wholesale services to other telecom operators back in 2014.

It wanted to upgrade its existing 18,500km dark fibre network, known as FTNx, to cover a wider geography. Other utility companies, such as those providing electricity, may also be able to provide dark fibre in the future.

Why dark fibre?

The main reason to deploy dark fibre is control. It gives organisations the ability to put their own electronics onto the fibre, controlling the network end-to-end. In turn, this gives them benefits like having more certainty over some costs, and over the security of their network – particularly important for government, financial services companies and banks. Other elements of control include scalability and latency.

Dark fibre also provides challenger networks the ability to evolve their customer base without having to partner with infrastructure companies, who invested in the build of the capability.

Whether this creates a more open, accessible market – or a negative distortion that discourages further network expansion – is an ongoing debate. Virgin Media Business is firmly in the latter camp.

1. Network design and maintenance

Transmission design is very different to designing the types of Layer 3 MPLS networks that many providers are familiar with.

It is relatively simple to put point-to-point solutions together, but it's quite often not 'complete'. When considering DFA there are other elements to build in; aggregation circuits, for instance, should have resilience.

To crack this, transmission teams that fully understand optical technologies are required. Without this, a challenger network provider can't compete with the new active or managed services provided by companies that do. Which, on the face of it, sounds feasible. Just hire in more teams and capabilities. But it's not quite that simple. Few companies have hitherto seen the benefit of DFA. Which has led to a dearth of available talent. We struggle to recruit engineers and often train our own. But without the base skillset, this isn't possible.

The next best solution then starts to erode some of the benefits of dark fibre. While using a DFA product to create independence from an infrastructure player, they may have to partner with them to design – and maintain – their own network. Just as if a managed access product had been purchased.

Single or paired fibre?

The knowledge required is not only deep, it's also wide. There are many potential pitfalls. One of the easier complexities to explain is the choice to be made between a single or paired fibre.

The cheapest option is to buy a single fibre on which you can transmit 1Gb or a single 10Gb. However, if and when a company wants to work on a more sophisticated solution – for example, adding amplifiers or attenuation to balance everything – then they'll have to consider investing in fibre pairs.

If they have a single fibre then the transmit and receive lasers are operating over the same fibre. However, if they have a pair then one can be for transmitting and one can be for receiving – in which case you need more equipment. Making the right economic decision must be taken on a case-by-case basis, depending on the level of sophistication necessary.

"I use fibre pairs because the top-of-the-range DWDM equipment we use requires a pair. You can definitely buy smaller and cheaper items that need just single fibre working, but then it's limited to how far you can go and how many wavelengths you connect over it, which is critical to achieving economies of scale." said Paul Brooks, Solution Architect at Virgin Media Business.

Core, Aggregation and Access

But to illustrate the depth and width of the implications raised by dark fibre, we need to first understand the network and the basic layers of access, aggregation and core. The kind of dark fibre proposition that will be used is dependent on the ability to build volume. So as you step through from core to aggregation to access, it is a matter of increasing volume.

A core network is built up of tens of high bandwidth circuits, while an aggregation network is built of at least a hundred circuits – or potentially hundreds. An access network is built from thousands of circuits dependant on how many sites you are connecting.

With 'lit' fibre propositions that currently exist in the UK, customers procure a service from 'A' to 'B' and the partner or provider they choose will install the fibre, put on the required equipment at the end of it, and get it working.

So if the customer requires a core network with tens of circuits then it is quite possible they will be able to achieve that. It would mean having to potentially outsource the work to engineers to build up the circuits. However, when the customer gets to the aggregation level this becomes more difficult because they need a number of engineers. This is extremely hard on the access level as it is then a matter of having numerous sites, with engineers needed every week or even every day to light up the fibre: Essentially, the requirement would be for an army of engineers.

While some companies may have a big enough engineering outfit to cope, the majority will have to scale up their manpower and technical capabilities to be able to exploit dark fibre to its full potential.

This isn't restricted to resources however, as companies will need the operational capabilities, with both systems and tools to configure things automatically, in order to monitor and maintain these networks. For example, the boxes that are installed at the end of the fibre have firmware installed on them and this needs upgrading from on a yearly basis.

Another difficulty with DFA in regards to both core and aggregation networks is the distance constraints it has.

A core network usually consists of major data centres or hubs – and this can be scattered around in the UK: one in Manchester, one in Scotland, a few in London and one in Leeds, perhaps with 10 to 20 core sites around the country that would be linked up. Because they're typically a small number of sites, the distances are often quite long between them.

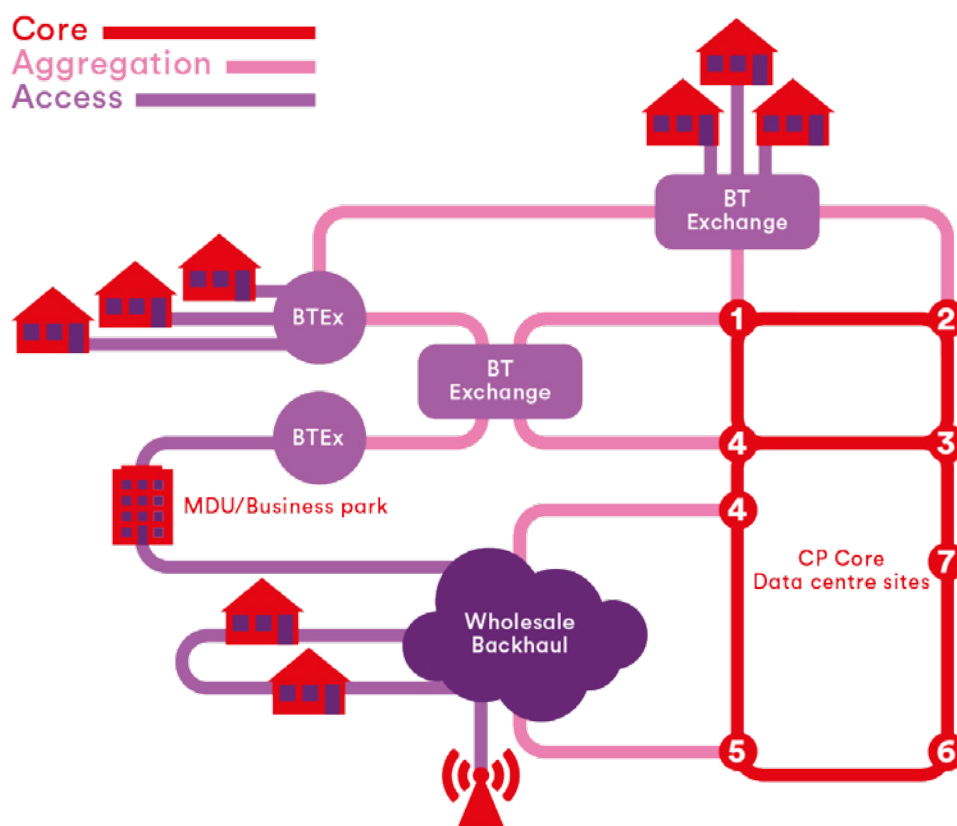
DFA has a distance constraint to it, which would struggle to compete with existing long haul routes provided by us or others. In aggregation this is less of a constraint but it can still cause issues if there is a long distance between two particular sites.

If customers did want to press ahead with a long route of their own, it would require some additional tweaks to make it work.

“If you imagine that a bit of light has been generated in this piece of +100km fibre, the longer the piece of fibre is, the weaker that light becomes – so you have to Amplify/regenerate that light again, which means you need additional nodes at about every 60km to 80km to get through the full +100km distance,” said Ian Bunning, Senior Product Manager at Virgin Media Business.

This means having a fibre that reaches between A and B, and then another piece from B and C. Many of the providers will not have the real estate to be able to regenerate and amplify circuits, and other methods such as splicing circuits in footway chambers can’t be used with DFA. The additional tweaks here also mean additional costs, which make the proposition less attractive for those after the core network.

WHERE CAN DARK FIBRE BE DEPLOYED IN THE NETWORK?



2. What happens when a fibre breaks?

The one area that dark fibre customers can rely on for help is a fibre break. If a utility company's drill has gone through a cable, the infrastructure provider is clearly liable. Dark fibre is leased, not purchased. However, as the provider is not lighting the fibre, the operator will have to inform them when there is a break. And prove it's the fibre and not their equipment at fault.

This means the company will have to have some optical capabilities in transmission, including – at minimum – an optical time-domain reflectometer (OTDR) and insertion loss measurement (ILM) testing. This means investing in test equipment, as well as ensuring engineers are skilled enough to use it. Unless, of course, they outsource it and move closer to a managed service model.

3. Meaningful innovation

Even if a market challenger does manage to find the expertise at the recommended level to design and maintain their dark fibre network, they may struggle to do much else with it. Telco providers have spent decades and hundreds of millions of pounds researching, developing and taking products to market. This has created a significant competitive advantage that will be difficult to overcome.

In other words, having an impact on the telecoms market is much more difficult than providing a DFA product.

4. Getting to grips with the industry

In addition to the technical, operational and financial complexity a purchaser of DFA would be well-advised to keep up to speed with regulation and other elements of the telecoms industry. For instance, the government proposed a plan to introduce a five year relief from business rates on new fibre optic/ broadband infrastructure, due to be enforced from April 2017. However, the General Election derailed these plans and the government has since announced The Telecommunications Infrastructure Bill to Parliament to provide 100% business rates relief on investments in fibre optics. That bill has been backdated to April 2017.

And this is just one of dozens of issues providers are tracking over time. Some will impact on a DFA purchaser, others won't. But it's impossible to know if you're not active in the industry.

What does this all mean for the UK?

Ofcom believes that the market would benefit from DFA and suggested that the dark fibre product be aligned to BT Openreach's EAD product, which is an active ethernet product or access product, working short distances from the customer site to an exchange, or similar.

Its theory is that people want dark fibre access to use an access product. But does it? A glance at the access market suggests there is still less than 1Gbps in the vast majority of circuits with no sign it is going up above and beyond that at any particular pace within the next three to five years. This is despite bandwidth growing overall. Indeed, one ground of BT's successful appeal was that Ofcom had got their market definition wrong by categorising all bandwidths in a single market.

The cost difference between a DFA service that a customer does on their own, or a ready-made EAD service, is not significant; therefore it is more beneficial to buy an active service for almost all of the market. So while Ofcom's initial decision was to introduce it at the access level, because of the volumes and the operational requirements, and the marginal cost differences, it is unlikely that companies are going to consume it for access services; they'll consume it for aggregation and core networks.

Is there any case for more dark fibre in the UK?

Perhaps. But there's a stark difference of experience in the UK compared to the telecoms markets in the US.

The lack of traction in the UK DFA market is perhaps a sign of the general, long-standing maturity of competition for telecoms and network services in the UK. Privatisation and network investment began here early. The penetration and density of networks is also much higher than the US.

And, with the competitive dynamic in the managed services market well established, providers can already get the services they want.

In fact, there's a broader range of network services for both business and residential customers, so there's higher take-up of managed data network services rather than point-to-point, which is bigger in the US. So, for example, IPVPN has a much higher penetration in the UK. With a mature set of scalable network services, the market need for dark fibre is necessarily diminished.

However, it is worth noting that in the US, Dark Fibre is used in the core level, where as in the UK, the consideration for dark fibre has also been in the access layer – particularly the mobile and MNVO space – and this is where much of the complexity comes in, and where the costs are insurmountable.

Conclusion

There are many challenges to dark fibre, particularly knowing what is best for your business, compounded by a very real skills gap. Whilst an initial glance may lead one to believe it's a cheaper alternative, it is easy to miss the implications of how much is being taken on.

However, for some businesses and their business models it can, if they get it right, be the correct move. In other circumstances, the best option may well be to consult a specialist and then partner to innovate and deliver the business strategy, rather than seek out a new technical domain involving dark fibre.

The critical point is this, as many have doubtless already concluded:

- Whichever part of the market you approach it from, dark fibre needs more careful consideration than is immediately apparent.
- It has its benefits. But rush in at your peril.
- And if you'd like to know more, we're always here to discuss the complexities at length.

To find out more visit www.virginmediabusiness.co.uk

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