Offering really high speed fixed broadband to all who need it would seem to mandate rolling out optical fibre to the customers’ premises, according to the industry and a number of operators and equipment manufacturers are trying to show this is true – but only up to a point.

They point to a bewildering array of technology and economic options for upgrading broadband networks, with emerging standards and technologies targeting legacy ‘last mile’ copper connections.

One of the most promising is G.Fast, a DSL variant that essentially extends the frequency range and thus the capabilities of copper, promising operators the potential of offering fibre-like data rates without having to make the huge investments needed to take fibre directly to homes and offices.

The operators that have, to date, done most of the ‘heavy lifting’ needed to get G.Fast standardised at the ITU and who are trialling the technology, believe it makes economic sense in the medium term to ‘sweat’ their copper assets to the maximum. These include AT&T, Swisscom, Deutsche Telekom, Canadian carrier Telus, Israeli carrier Bezeq and, most enthusiastically, BT. These have strong support from some of the biggest names in the communications equipment sector, including Adtran, Huawei and Nokia (via its acquisition of Alcatel-Lucent.)

The three semiconductor groups best established with chipsets and reference designs for G.Fast are Skippio, Broadcom and Ikanos. The latter was acquired by Qualcomm in August 2015, but its DSL operation was said to have closed several weeks ago.

Last year, Intel made an undisclosed but strategic investment in Israeli start-up Skippio, which was established some five years ago to exploit the potential of G.Fast.

Ultra-fast broadband
According to Trevor Linney, BT’s head of access network research, “G.Fast has become an integral part of our

Fighting fibre with G.Fast

With a bewildering array of technological options available to upgrade broadband networks, many operators are looking to G.Fast to extend the capabilities of their copper assets. By John Walko
plans for ultra-fast broadband and we are really encouraged with the progress made by our partners, and with the latest feedback from the various trials that we have been conducting."

He told New Electronics the operator now plans to offer G.Fast-based services, operating at between 300 and 500Mbit/s, to 10million UK premises by the end of the decade. Those, of course, are the download rates; unfortunately, upload rates are nearer the 50Mbit/s mark.

As to effective reach, he suggests the optimal distance would be 300m; the typical distance between a street cabinet and the customer premises.

Eventually, it was thought the technology would only perform to the necessary bit rates over distances of up to 100m. "But, working with industry and standardisation efforts, we have achieved a repeated renaissance when it comes to speed and distance through improvements in cross talk interference, or vectoring. This, and the fact that we are now able to use significantly higher frequencies, has been key to the advances we are seeing," Linney stressed.

Not that any of this has been plain sailing from a technological standpoint. "To squeeze out the maximum potential from the installed copper networks, there are two significant barriers to overcome. One is the length of the line, since signal strength will diminish as the distances become longer. Then there are problems due to interference between copper pairs.

"Really high data rates can only be achieved by deploying the highest possible frequency, but the higher the frequency, the greater the noise and the lower the capacity. All these factors needed very clever and intricate signal processing and maths to achieve the most efficient ‘rate versus reach’ ratio", said Linney.

And all this had to be done while ensuring there was no interference at all with the existing VDSL2 technology used in the access network. Here the use of spectrum guard bands will play a crucial role.

He noted that while vectoring – which uses Multiple Input, Multiple Output signal processing to mitigate crosstalk and allows single line performance – was optional for the current flavours of DSL, VDSL and VDSL2, it was mandatory for G.Fast.

While VDSL works at either 17MHz or 30MHz, the early version of G.Fast is designed to operate at 106MHz. There is an important tweak in the pipeline being discussed in regulatory bodies that will double this to 212MHz, making use of some novel coding technologies under development.

Linney points to another significant challenge to any commercial roll-out of G.Fast – the availability of sufficient distribution ports on the current generation of DSLAMs. Eight to 16 ports was just not enough for deployment at the cabinet locations targeted by BT for a roll-out. Linney suggests at least 96 ports in distribution points (DPs, where fibre from the central office meets the existing copper wires that connect residences) would be the ideal.

Here, they would be deployed in existing street cabinets that house the gear needed for vectoring capabilities, a scenario that would make G.Fast more commercially favourable for operators looking for alternatives to investing in fibre to the home (FTTH) or fibre to the premises (FTTP).

Such a scenario was boosted a few weeks ago when the Broadband Forum, the industry pressure group and standardisation body, sanctioned the latest specifications to improve the performance of DPs. Dubbed TR-355, they target the management of fibre to the distribution point and comprise software modules written in the YANG data modelling language. This should allow operators to configure and control DPs remotely and the Forum stressed this will ‘provide further stimulus for developing technologies such as G.Fast’.

Sharp intakes of breath

Linney noted BT’s decision to go from the typical 16 ports to at least 96 ‘generated sharp intakes of breath amongst many of our vendor partners’. "But the suppliers responded magnificently and such gear is now on most of the chip designers’ and equipment vendors’ product roadmaps," he told New Electronics. The latter include companies such as Adtran, Huawei and Nokia and Sckipio, all of whom are involved in at least one of the G.Fast three field trials BT has been or is conducting.

Huawei and Nokia have also provided trial CPE units for these field tests, as have Technicolor and Zinwell.

BT has been conducting large scale trials in Huntingdon and Gosforth since the summer of 2015, with

G.Fast is becoming an integral part of BT’s plans for ultra-fast broadband across the UK

The test network for G.fast tests layouts for the copper loop from the cabinet to the premise using a variety of configurations

Cover Story: Ultra-fast broadband

The test network for G-fast tests layouts for the copper loop from the cabinet to the premise using a variety of configurations.
around 2000 premises signed up for both. Subsequently, technology trials in Swansea have focused on deploying the technology to ‘Multiple Dwelling Units’, or blocks of flats, as well as some business centres. Reports suggest more than 75% of the lines were able to deliver more than 300Mbit/s download and upload rates of 30 to 50Mbit/s upload. Around one third of these lines were shorter than 100m and about 15% were between 200 and 300m.

“The trials were positive and met all our and the vendors’ expectations. The next stage is to set up a pilot passing some 25,000 dwellings in two locations”, said Linney. The trials also corroborated BT’s earlier decision not to roll out fibre to distribution points close to customers premises – as had been envisaged early on in the project – but rather to provide G.Fast from many of its 90,000 street cabinets dotted round the country. BT previously said the former approach would have been ‘untenable’ from an economical viewpoint, with the operator having 4 million DPU’s across the UK.

BT has indicated that rolling out G.Fast using the FTTC model could be managed within the carrier’s ‘existing capex envelope’, but without offering any figures. It also stressed that G.Fast would co-exist with VDSL2 for a long time.

The start of the G.Fast story

Linney cautions that this is just the beginning of the G.Fast story. “The technology first emerged back in 2006 as part of a European Union collaborative project. Industry then started a standardisation process at the ITU in 2011, which, while slow at times, came up with the first specs for G700 and G9701 in 2014. There have been some changes following further research and operational needs, with input from some 100 companies, notably BT, equipment suppliers such as Huawei and chip group Sckipio.

“We have overcome some big engineering challenges, but I foresee several more ahead.”

He suggests the key outstanding issues include enabling higher bits per tone, typically 15, rather than the 12 to 14 now; better receiver sensitivity (less than -150dBm/Hz); increasing the transmit power from 4dBm to perhaps 8dBm; optimising the frequency usage with VDSL2; and increasing the vectoring group sizes to 96.

BT is also a major proponent, together with Alcatel-Lucent’s Bell Labs, of a follow-on variant dubbed XG.Fast that has delivered 5Gbit/s over 35m at the operator’s Adastral Park research facility and at Bell Labs’ Antwerp technology group. Data rates of 1.8Gbit/s have been achieved over copper loops of 100m. “This is, of course, a research project,” Linney noted, “but it does signpost that copper has the potential to deliver even higher speeds.”

As of now, though, this would not help in getting ultra-fast broadband over longer distances, since XG.Fast operates at 500MHz.

So, while G.Fast is no panacea, it is likely to play a key role in helping operators upgrade the access network in the near future. But in the longer term, there is little doubt fibre will win.