Fibre optics

The glass ceiling

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Optical fibres could carry more information in the future

WHAT is the theoretical limit to the rate at which information can be sent down an optical fibre? With telecoms firms' shares in the doldrums and widespread talk of a glut of capacity, this might seem an odd time to ask such a question. But that is what a group of researchers at Lucent Technologies' Bell Laboratories in Murray Hill, New Jersey, have done. And they have found that the limit is far beyond the reach of today's technology, which means that there is plenty of scope to increase capacity in future—or, to look at it the other way round, that the present glut is even bigger than it looks.

Sending large amounts of information down an optical fibre is done by encoding many separate streams of data as pulses of light of different colours, so that they can travel along the fibre without interfering with each other. Today's technology allows a fibre to carry 160 such streams, each with a capacity of 10 gigabits per second (one gigabit is a billion binary digits). This gives a total capacity of 1,600 gigabits, or 1.6 terabits (a terabit is a thousand gigabits), per second. As the equipment at either end of the fibre becomes more sophisticated, the number of channels, and the capacity of each channel, increase, even though the fibre itself is unchanged. How far can the process go?

That is a hard question to answer, because light travelling along a fibre subtly changes the properties of the fibre itself, in a way that is difficult to model. What makes it even harder is that these changes are retained—the fibre in effect "remembers" recent signals for a short period of time. This means that, as more streams of data are added, they interfere with each other in very complex ways. It is rather like trying to distinguish between multiple overlapping conversations; easy enough when a handful of people are speaking distinctly in a quiet room, but impossible when everyone is shouting in a reverberant nightclub.

In a paper in this week's *Nature*, Partha Mitra and Jason Stark of Lucent explain that they have found a way to do this tricky analysis. By combining techniques from the fields of information theory and theoretical physics, they have devised a clever new model of optical fibres that is simple enough to analyse, but complex enough to capture the behaviour of the real thing. Using this model, Dr Mitra and Dr Stark concluded that the capacity of a single fibre is at least 100 terabits per second (the same amount of data as is on 28,000 full-length CD-ROMS).

So, the $35 billion spent in recent years laying optical fibre may be a good long-term investment. Little comfort to the firms that paid for it, many of which are unlikely still to be around if it is put to full use. But for the engineers working to squeeze ever more down each fibre, the new result proves that, even if the sky is not the limit, the ceiling is very far away.