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News

Bigger bandwidth

Mobile phones are ever more popular: in the UK there are now about 40 million users, and the number is still growing. As a result, more and more signals are filling up the airwaves. The British government's windfall of £22 billion last year, from selling off the rights to parts of the radio spectrum to mobile phone operators, is an indication of how valuable bandwidth is becoming.

Now Michael Andrews, of Bell Labs, and others, have found a way to triple the amount of data that can be transmitted at a given frequency, by showing that more independent channels of data can be sent than was previously thought.

Classical radio communication uses a single channel per frequency, though it is well−known that, by making use of polarisation, it's possible to send two channels. Light waves (including radio waves) can be thought of as vibrations: as the wave travels forward, it is vibrating either up−down or left−right. If the receiving equipment is sensitive enough to distinguish these two polarisations, then they can be used to transmit separate channels of information.

These vibrations are in the electric field strength of the signal. There is also a varying magnetic field strength, but since this is tied to the electric field (and at right−angles to it), it can't be used to send extra channels. Also, polarisation in the third direction − forward and back − is not possible, since the vibration must be at right−angles to the direction of the wave.

At least, that is what was previously assumed, and it is true for a signal travelling straight from source to receiver. Andrews and his colleagues showed that a different story holds true in a scattering environment − for example, indoors or in a town − where signals bounce several times before being received.

Because a bounced signal has not travelled straight from source to receiver, it *is* possible for its polarisation to be partly in the third, forward−and−back direction. Thus, in a scattering environment, three channels can be transmitted to a receiver measuring the electric field in the three different directions. In addition, they showed that the scattering allows the magnetic field to vary independently from the electric field, giving, in principle, the possibility of another three channels. There is therefore room for six channels in total, rather than two, as was previously thought.

In passing, their paper also mentions the intriguing possibility of a further increase in the theoretical bandwidth, by exploiting not only the signals themselves, but their rates of change in space, as independent

variables.

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Plus is part of the family of activities in the Millennium Mathematics Project, which also includes the NRICH and MOTIVATE sites.