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Cell phone antennas get ‘smarter’

Antennas for mobile phone services can now ‘home’ and listen to individual subscribers, says **S.Ananthanarayanan**.

The basis of mobile telephony is the division of a region into ‘cells’ so that a frequency used in one cell can be re-used in a cell a little away from the first one. The new ‘homing’ antennas can allow the frequency to be re-used in the same cell!

The antenna array

In simple broadcast, like used for radio of television, the antenna is one vertical wire carrying a current that alternates thousands or millions of times a second. This radiates waves, equally in all directions, growing weaker as they spread out. But if we had a pair of antennas, parallel and separated by half the wavelength of the waves, then the waves from the antennas would interfere and cancel out or reinforce each other, depending upon the direction.

As we can see in the diagram, along the direction of the two antennas, the ‘crests’ of the waves from one antenna fall on the ‘troughs’ of the waves from the second, and cancel out. But along the direction through the center of the antennas, the ‘crests’ and ‘troughs’ come together and add to each other. The signal radiated thus becomes ‘directional’.

Even when receiving signals from subscribers, the signals received by the two antennas would be ‘in step’ or ‘out of step’, depending on where the subscriber was. This information can be used to turn the antenna pair around so that both transmitted and received signals are the strongest.

Smart antennas

But the antennas now used do one better. In place of physically turning the plane of the antennas, the signals received or transmitted are electronically ‘delayed’ or ‘advanced’, so that they are strongest in a chosen direction. In the pair of antennas, for instance, if the signals were generated ‘out of step’, then it is in the direction along the two antennas that the waves would ‘reinforce’. The signals received by the antennas from a particular direction could similarly be adjusted so that they ‘add’ when they are mixed, and ‘listen strongly’ in that direction.

The Cocktail Party effect

Our own ears use exactly the same thing to identify the direction of a sound. When the same part of a sound wave strikes both ears at once, we know the sound came from directly in front or behind. And if they are ‘out of step’, we get used to guessing where they came from, depending on the pitch of the sound and the size of our head.

In a crowded room with many voices speaking at once, like in a cocktail party, the brain can decide to pick out sounds ‘just so much out of step’. This would select a particular, soft conversation, amidst all the din, to listen to.

Adaptive antennas

‘Smart’ antennas use this idea to ‘tune in’ to a subscriber when she starts using the service. The ‘tuning’ can be adjusted even as the subscriber moves around. In fact, the signal is affected not just by movement of the source but also by objects, like buildings or moving buses, which reflect radio waves. Smart antennas can ‘adapt’ to changes, like the bus moving away, to maintain the quality of service.