Double antennas deliver double the signal

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Digital TV transmission techniques that deliver most benefit in the worst reception environments have been developed by a consortium of European researchers. The technologies promise to reduce the network infrastructure needed for mobile TV, while minimising the power demands and complexity of mobile TV receivers of the future.

In a typical broadcast transmission, radio signals bounce off objects in the environment, reaching the receiver over multiple paths. Distortion from 'multi-path' signals can produce fading, resulting in temporary failure of reception. Most of us have experienced this, moving a mobile phone around a room to get the strongest signal.

Modern broadband wireless technologies like WiMAX, DAB for audio, and DVB-T and DVB-H for video, use a modulation scheme called Orthogonal Frequency-Division Multiplexing (OFDM).

An OFDM transmission is spread across thousands of different sub-carriers, each carefully organised at slightly different frequencies within the channel. Spreading the transmission across a high number of sub-carriers increases the probability of maintaining error-free transmission.

Researchers have demonstrated that splitting the transmit power between multiple antennas can provide substantially more effective coverage than using a single antenna. Signal simulations carried out for project Pluto show a gain of up to 5 decibels could be achieved. The Physical Layer DVB Transmission Optimisation (PLUTO) project comprises a consortium of academics, equipment manufacturers, propagation experts

and broadcasters from Finland, France, Germany and the UK, co-funded by the European Commission.

Best in worst environments

The transmission-splitting technique under development by PLUTO, known as 'transmit diversity', benefits the worst environments most. Reception can be spectacularly improved indoors, or whilst walking or driving in cities. Fewer transmitters and less power are required to achieve economical coverage.

"This technique does not require revision of any WiMAX, DVB or DAB standards," says Maurice Bard of UK company Broadreach Systems, the technical leader of PLUTO. "The great advantage is that it can be exploited by existing in-service receivers without modification. All you need is an additional box that can split the signal."

"The transmit antennas need to be spatially separated by between 10 and 20 wavelengths and a delay applied to one antenna to achieve effective de-correlation. The amount of separation and delay depends on the type of environment to be covered," says Bard.

Coverage can be further improved if there are two or more antennas at the reception end, he explains: "For receive diversity, you need to separate the receive antennas by at least half a wavelength which is approximately 25 centimetres at UHF frequencies. If this can be achieved, then transmit and receive diversity can work together to deliver even greater benefits. The benefits of receive diversity, however, can only be exploited in terms of network design if all receivers in the network have diversity implemented."

Filling in black holes

Even with the reception improvements promised by transmit diversity, there will be reception black spots, particularly indoors, where on-channel repeaters will be needed. An on-channel repeater receives a signal from a distant transmitter and re-transmits it at the same frequency. The repeaters are prone to instability caused by the feedback of echoes from the transmitter to the receiver. Here, the academics at Brunel University, led by PLUTO project coordinator Professor John Cosmas, have developed an innovative method to remove these echoes.

A pseudo-random sequence is buried deep in the re-transmitted DVB-H signal," explains Cosmas. "The sequence acts as a signature, allowing the repeater to differentiate the unwanted echoes from the wanted original signal and remove them from the re-transmission."

"The method can work for repeaters of any OFDM based network."

Broadreach Systems has provided equipment to process signals at the transmitter and monitoring stations that intercept and measure transmitted DVB signals. The monitor stations are networked to a control centre, developed by Brunel, enabling the effects of diversity to be evaluated in real time."

There are still some hurdles to be overcome before PLUTO's transmit diversity solution is suitable for all types of broadcast networks. Transmit diversity actually results in a degradation in reception where the receiver is in clear line-of-sight with the transmitter and the signals from each antenna are received at exactly the same power level.

The line-of-sight reception loss may not prove to be a problem for many networks. In a mobile TV network, all receivers will be in a non- or near-line-of-sight situation, very few will have rooftop antennas. But 'good enough' is not a position that the PLUTO consortium is prepared to stop at if they are to change traditional thinking.

“We need to show that the performance we saw in the lab can be achieved in all real situations, rain, snow, cities …” says Cosmas.

“And, we have to convince the broadcasters who designed traditional analogue networks, where multi-paths had to be avoided, that multi-paths are good.”

Source: ICT Results