Vodafone Response to Ofcom Consultation:

Mobile Coverage Enhancers and their use in licensed spectrum

SUMMARY

Vodafone is all too aware of the issues of mobile not-spots, and we work with our customers to remedy coverage issues. In addition to reacting via deploying additional macro-cells where efficient, we offer our customers Sure Signal[1] equipment, whereby a femtocell can be created in their premises that utilises the customer's broadband connection. We are also developing our Open Sure Signal concept[2], to allow community deployment of this technology.

Vodafone does not favour any relaxation to the regulatory framework governing usage of licensed spectrum. We believe that it is essential that repeater deployments should require the specific approval of the network operator that has paid substantial sums for exclusive access to the spectrum concerned. Vodafone believes that any device capable of transmission must be under the control of the network and that un-coordinated repeater deployments have the potential to cause interference to the network and hence harm to other users. As Ofcom is aware, there are hundreds of documented cases of un-coordinated repeater deployments causing interference in the network.

The site engineering of repeaters is complex and requires a detailed knowledge of network conditions, and awareness of future evolution of the network is necessary for a successful deployment.

Vodafone must also remind Ofcom that it has a duty to ensure that licence holders have useable and interference-free spectrum to enable them to provide the best quality of service. Thus Vodafone would favour more rigorous enforcement. We also note that Section 62 of the 2006 Wireless Telegraphy Act gives Ofcom the powers to place restrictions on the sale as well as use of equipment, where it is considered it will result in harmful interference.

Vodafone has deployed a small number of repeaters in its network mainly for indoor coverage applications, but these have been introduced following a rigorous engineering approach, informed by knowledge of the architecture of the underlying network.

[1] http://www.vodafone.co.uk/our-network-and-coverage/what-affects-your-coverage/sure-signal/
[2] See news release : "Vodafone UK launches national programme focussed on rural notspots" July 2014, http://www.vodafone.co.uk/cs/groups/configfiles/documents/assets/18170.pdf

REPEATER BASIC OPERATION

Off-air Repeaters, also sometimes referred to as cell enhancers or signal boosters, are sophisticated bi-directional RF amplifiers. Repeaters comprise a power amplifier and a low noise amplifier in both the Uplink and Downlink paths. A directional antenna such as a Yagi is required at the donor port. The type of antenna(s) at the subscriber port is determined by the coverage area and the isolation needed between donor and subscriber antenna(s).

There are different types of repeaters manufactured with differing output power ranging from a few milliwatts to devices with output powers of tens of watts being equivalent to the output of a macro radio base station. However, all repeaters do share certain characteristics in common.

The purpose of the repeater is to extend the coverage footprint of the existing cell. The quality of the deployment is not just a function of the quality of the device itself but also of the site engineering. Poor site engineering can result in the repeater becoming an interferer in the underlying network.

REPEATER DEPLOYMENT ISSUES

Vodafone considers that given the complexity of the site engineering, repeater deployments could not be fully optimised without in-depth knowledge of the network and for this reason all repeater deployments must be co-ordinated with the network operator.

Site engineering is absolutely critical for the effective deployment of repeaters. Poor site engineering will at best lead to sub-optimal repeater performance and at worst actually damage the network and consequently compromise service for other users. It must always be borne in mind that a repeater can only amplify existing coverage and thus the quality of the output is determined by the quality of the input.

Repeaters require a suitable donor site and must be engineered in such a manner not to degrade the donor site or its neighbours. The main issues connected with site engineering are donor signal level, antenna isolation, donor capacity, antenna height and both co-channel and adjacent channel interference (unwanted signals). These parameters cannot be known by parties other than the rightful licensee of the spectrum in question, so there is no way that a third party could deploy a repeater independent of the licensee without risking interference.

DONOR SIGNAL LEVEL

The most critical aspect of repeater site engineering is to ensure that the Repeater is located such that it can receive sufficient donor signal. The donor signal received must be sufficient to ensure a reasonable output power while at the same time it must not be so high that it overdrives the repeater. The signal operation window will vary depending upon exact repeater

type. In addition to signal level it is also important to ensure that the signal is stable and not subject to deep fading. Vodafone believes only the rightful licensee can have proper knowledge of these aspects.

DONOR CAPACITY

Repeaters extend coverage but achieve this via redistribution of Radio Base Station capacity. Clearly for a Repeater to be useful there must be sufficient capacity on the donor cell to accommodate the expected increase in traffic as a result of the repeater. In some instances it may therefore be necessary to add additional capacity to the donor cell. Only the licensee can do this, and absent this activity, existing customers using the donor cell will have their service compromised.

DONOR ANTENNA

An optimum repeater deployment needs a line of sight path to the donor cell thus the repeater donor antenna needs to be highly directional; in practice this is normally a Yagi. For optimum antenna configuration in terms of type, orientation and height, detailed information of the donor cell is required.

ANTENNA ISOLATION

Normally to avoid self-oscillation there must sufficient isolation between the donor and subscriber antennas. This will be a function of the types of antennas deployed, their respective heights and orientations. Absent proper engineering on the part of the deployer, the repeater could not just fail to operate, but could interfere with the operation of the licensed network at a location which by definition will probably already have low coverage levels.

UPLINK NOISE

Since a repeater is an amplifier it is a source of Uplink thermal noise especially when it is not carrying traffic. The thermal noise produced by the repeater will to some extent desensitize the donor cell and depending upon the quality of the installation could have a similar effect on other neighbouring cells. The repeater site must be engineered to ensure that the coupling loss from repeater to donor is sufficient to ensure that the receiver performance of the radio base station is not impaired.

A poorly engineered repeater site with insufficient coupling loss will become a source of Uplink interference in the network.

INTERFERENCE MINIMIZATION

Since a repeater is an amplifier the quality of the output is determined by the quality of the input signal. The quality of the input signal will be determined by interference environment. Interference can be minimised by good site engineering in particular by antenna orientation and height. It should also be realised that while neighbour cells are a source of Downlink interference to the repeater, the repeater itself is a potential source of Uplink interference to the neighbouring cells. For this reason it is extremely important to ensure that the site is engineered to minimise interference.

To minimise interference the donor antenna should be as directive as possible and the antenna should be mounted above clutter level ideally with a clear line of sight to the donor cell. Information on the type of terrain and clutter should be available. There should be no clutter in the immediate vicinity of the donor antenna and the path to the donor site should not be obstructed by dense clutter.

To ensure that the site has been optimally engineered to minimise interference would require detailed knowledge of the network and it is therefore all but impossible that any un-coordinated repeater installation could be optimised for minimum interference.

MONITORING & ALARMS

Any active device in the network should be alarmed to alert of a fault with the device. Repeaters deployed by the operators can be integrated into the network operation and maintenance systems. It would not be possible to integrate un-coordinated repeaters into the network operation and maintenance system.

NETWORK EVOLUTION

A repeater deployment can never be a fit and forget installation. In any repeater deployment consideration must be given to network evolution. Cellular networks evolve continuously and thus there must be processes in place to ensure that any repeater installation can evolve with the surrounding network. Specifically a repeater needs to be considered as a site that is integral to the main network and as with any site there must be a process to ensure it can evolve with ongoing network deployment and optimisation activities e.g. new donor cell, re-orientation of the existing donor cell, cell split, changes in antenna down tilts and frequency retunes.

Significant re-engineering of the donor site or other sites in the area could make the repeater no longer viable and even more seriously turn the repeater into an interferer.

Repeaters must be visible to radio coverage planners so they can be removed from the network when they are no longer necessary or present an interference risk.

Currently Vodafone and Telefonica are undertaking a RAN share which involves massive re-engineering of both networks. Because it is known where the co-ordinated repeaters have been deployed they can be appropriately managed with the devices being retuned, removed or replaced as required with minimal disruption to customer service and network integrity. Clearly if un-coordinated repeaters had been deployed it would not be possible to do this and customers would suffer loss of service and the network would suffer interference. This illustrates why it is essential that repeaters are visible to the network operators.

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