Femtocell Networks

BACKGROUND

As wireless telecommunications usage increases, one of the popular solutions for providing good quality signal coverage for customers in densely populated areas is to deploy femtocells (aka smallcells). A femtocell is a small, low-power cellular base station that allows network operators to extend or/and enrich their coverage however this approach can also increase interference within the network. The University of Manchester team have developed a novel software -based method that governs radio spectrum allocation to mitigate interference. The novel approach utilises already generated data information with no need for additional hardware. The potential for this software is that it would be implemented in every femtocell and capture a sizable segment of the US$5billion (2017 forecast) optimisation and 'self-organising network' software market.

In the telecommunications Industry, global mobile data traffic is forecasted to increase nearly 11-fold between 2013 and 2018.[1] The escalating popularity of mobile devices results in the cumulative demand on wireless capacity (data rate). Each network operator has a limited allocation of radio spectrum, and therefore high demand results in overuse of spectrum and hence performance degradation. Mobile network operator's solution therefore, is to deploy femtocells to residential or enterprise customers where interference is high due to the density of users. For a mobile operator, the attractions of a femtocell are better spectrum management and better network capacity, especially indoors where 80% of the data traffic is generated. Consumers benefit from improved quality of service and potentially battery life.

THE TECHNOLOGY

The technology aims to mitigate interference between macrocells and femtocells as well as between different femtocells in LTE networks and beyond. The technique (known in the Industry as Radio Resource Management - RRM) introduces the creation of local and global conflict matrices which map interference in a simple binary format that can inform the allocation stage in optimising the network performance by enabling efficient sharing of the radio spectrum to achieve the best balance between resource utilisation and interference minimisation.

A 'C' Software source-code function is ready to be incorporated into an Industry partner test bed processor for validation. The University of Manchester team has verified performance through accurate computer modelling & mathematical analysis. Results show that significantly improved performance can be attained in a variety of areas, including average throughput, quality of service (QoS) and power consumption.

A UK patent has been filed (August 16th 2012) protecting the algorithms and methodology.

[1] http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

KEY BENEFITS

The University of Manchester technique achieves:

- Improved average data rate by more than 20% in high femtocell density and up to 50% in low density, hence significant enhancement in spectrum utilisation.
- Improved quality of service (QoS) by at least 50% in high density and up to 300% in low density, hence greater user satisfaction and/or greater number of serviceable users.
- Reduced power consumption by at least 37% in low density and up to 70% in high density, hence great reduction in opex4 and improvement for green comms.
- Support/compatible heterogeneous networks, fits well with future direction

The competitive advantages over current RRM techniques include:

- The Industry practise of reducing power to the femtocell base stations to lower coverage (and minimise interference) is not required.
- Does not require any additional hardware
- Does not require any additional channel state side information per user
- The feedback exchange with the central unit is minimal
- Fast converging algorithm hence resulting latency is minimal
- Self-adapting to any kind of environment with respect to user and base station densities
- Achieves equal quality of service for femtocell users and macrocell users

Current self-organising network techniques use half the available spectrum allowing for allocation flexibility, whilst with University of Manchester the full spectrum is managed and optimised within LTE standards with no additional hardware required.

APPLICATIONS

Implementing femtocells can improve spectrum utilisation but brings the challenge of interference because

- Femtocells use the same frequency bands as the conventional cellular network.
- Installation of femtocells in the networks is end user driven and leads to uncoordinated transmission.
- Density of femtocells could be as high as 1 femto every 5 metres in very dense scenarios.

The University of Manchester approach aims to address these issues with demand being from the network operators directing their equipment suppliers to apply the technique in order to enhance their customer experience. It is anticipated therefore that he technology will be interest to both wireless network operators and the suppliers of femtocell equipment.

NEXT STEPS

The primary focus of The University of Manchester team will be to create add-on functionalities that can be incorporated within existing protocol stacks. The ultimate aim is to provide the full suite of protocol stack (i.e. network operating system) which would include various functionalities. A series of modular innovative functionalities would then be seamlessly utilised within the protocol stack of wireless networks to enhance efficiency and reliability. The functionalities could include, but are not limited to, intelligent radio resource management, power management, flexible access protocols and load-balancing to jointly optimise power and spectral efficiency while considerably increasing users' satisfaction. Such performance improvements would have a significant impact on the cellular Operators' net returns.

CONTACT

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