Advances In Interference Management Make LTE HetNets a Reality

Ilan Vardi, vice president, product management and marketing, AirHop Communications

The dramatic success of the iPhone, data hungry smartphone competitors and other wireless devices is placing an ever increasing capacity demand on wireless networks which is only expected to worsen with the accelerated deployments of 4G networks worldwide.

Heterogeneous networks (HetNets) have been a solution with great promise to solve the data tsunami that is coming from the growth of these devices. But some doubt that the industry can overcome interference challenges with this unprecedented network deployment.

In this publication alone, one writer called HetNets "hype [1]," and another asked whether they are really the answer [2] to the bandwidth problem of LTE networks. The challenge to deploying HetNets is real, but some solutions are also emerging that will make HetNets a realistic solution carriers can tap to realize the cost, coverage and performance advantage of this network design.

In the U.S. today, wireless networks are built out using some 250,000 macro cell base stations, each covering a diameter of up to 3 kilometers and each carefully located to minimize radio signal interference. This network topology, originally built out for voice services, is straining under the exponential increase in smartphone data traffic.

The HetNet topology builds a network that includes existing macro cells and complements them with millions of smaller base stations, including micro cells and pico cells, appearing on lamp posts in urban areas and femto cells appearing in homes, residential high-rise apartments and businesses. The small cells provide a very efficient way to offload high traffic areas from the macro cells and therefore increase cell capacity and optimize spectrum utilization.

The large-scale introduction of mostly, un-planned small cells also creates new challenges for mobile operators. In order to minimize OPEX, there is a requirement for self-discovery and self-configuration during the initial setup phase of small cells deployment.

While there is extensive hype in the industry about "multi radio access technology

(RAT), multi-vendor" type of HetNet solutions, the more imminent and practical solution is the interference avoidance required when small cells are rapidly added to existing LTE Macro centric networks.

During operation, the key challenge is to manage inter-cell interference and to provide intelligent multi cell, multi-vendor coordination and optimization between the macro-cell layer and the small cell layer as well within the small-cell layer itself.

The SON standard is defined by the 3rd Generation Partnership Program (3GPP) and specifies algorithms to enhance the planning, deployment, operation and optimization of the network. Based on this standard, a SON algorithm will run upon startup of the small cells, allowing the device to insert itself into the network without interference. In terms of interference management, 3GPP introduced inter cell interference control (ICIC) in Release 8 and more recently, in Release 10, the enhanced ICIC (eICIC) standards. These standards are specified to mitigate interference in neighboring cells by using the power and frequency domains in the case of ICIC and adding the time domain for eICIC. Both standards rely on the X2 interface to exchange information between eNode B's and typically require a client/server or hybrid deployment in order to perform the optimization and coordination functions.

But there are some limitations to standard ICIC in multi-vendor networks. What's needed is a capability we're calling coordinated multi-cell interference management (MCIM-C). This algorithm is purposely designed for small cells deployments in LTE HetNet's.

MCIM-C can be deployed using either X2 or proprietary interfaces, which expands the deployment flexibility and is particularly suited for multi-vendor environments where the X2 interface is not uniformly present. In addition to taking in to account power, frequency and time domain, MCIM is also using the user's QoS/QoE as input in its interference mitigation algorithm. By using the alternate interfaces, the MCIM-C algorithm can be effectively deployed not only in hybrid mode but also in fully distributed (eNode B only) and centralized modes.

Using advanced system level simulations tools, the gains resulting from enabling multi cell interference management algorithms can be predicted. In a HetNet environment, the results will vary based on the input parameters used and a range of 5% to 40% improvement in average data throughput is predicted when the algorithmis enabled.

Taken together, these algorithms provide the only spectrum re-provisioning and bandwidth-allocating solution designed specifically for heterogeneous wireless networks (HetNet) that include small cells. They can prevent interference between small cells or between a small and a large base station—regardless of the proximity of the two cells, which will therefore result in a significant capacity increase.

HetNets are not hype, but instead a great idea that leverages the current infrastructure in a way that can flexibly address bandwidth hot spots resulting in better coverage and throughput for the network as a whole.

Ilan Vardi is vice president of product management and marketing, AirHop Communications.

Links:
[1] http://www.wirelessweek.com/Articles/2012/05/Seeing-Past-the-HetNet-Hype/
[2] http://www.wirelessweek.com/Articles/2012/07/technology-Are-HetNets-the-Answer/