Are We Ready for Small Cells?

Posted by Frank Rayal on Jul 15, 2013 10:07:00 AM

The topic of small cells has been a much discussed in the last few years, in both industry and academia. Despite significant investments in this space, the ecosystem awaits the "pick-up" in volume deployments of outdoor, licensed-band, carrier installed small cells. The leaves one wondering if small cells, in their outdoor, zero-footprint and licensed band operation, are riding a hype cycle.

To put the issue into perspective, GSM and 3G "microcells" have been deployed by operators for many years to address network capacity and coverage deficiencies. These were the first types of "small cells": outdoor base stations at low height above ground. More recently, zero-footprint compact base stations incorporating advances in silicon processing and RF technologies to drive the cost of former "microcells" lower through greater integration have become available. The theory goes if small cells are low enough in cost operators would deploy them in volume.

But for outdoor small cells this has not happened, yet. Looking at the technical aspect, and leaving aside business case issues which are in no way less important, a number of issues arise to challenge the mass-scale deployments of small cells. One of the major challenges is self-organizing network (SON) capability in the true and original sense of this definition. Here, by SON I mean the ability to optimize network performance automatically and without human intervention. For a wireless network, this means the ability to optimize network parameters to control interference which has a major impact on performance. It also includes the ability to manage the traffic load on different radio access network elements to provide the user with the best possible service while keeping tab on overall network performance.

When it comes to true SON, I think we are still in the early days. The wireless network features complex interactions between base stations. In the traditional cellular network architecture, this was an interaction between equals: base stations of relatively similar transmit power and coverage area. Adding a small cell layer underneath the macro cell layer increases the complexity of managing the performance by orders of magnitude. The small cells have much lower output power and coverage area. Interference and load can vary significantly at any particular moment. In fact, placing a small cell in the wrong spot reduces network performance.

The complexity is also represented by quantity and variety of data which is spewed out from different network elements constantly. Here, we enter the realm of big data where traditional ways of handling network fault and performance metrics are no longer sufficient in the era of heterogeneous networks, particularly as network 'events' would set to increase dramatically. Fast, automated optimization algorithms become necessary to help the operator in the gigantic task of network optimization resulting from the volume deployments of small cells. In this regards, machine learning techniques would need to be implemented to predict the performance of the network given changes in certain parameters.

SON facilitates the integration of other type of small cells such as indoor residential femto cells, remote radio headends in cloud RAN deployments and Wi-Fi access points. But what happens if these elements are provided by different vendors? Already we see gaps in the implementation of the X2 interface, a major conduit for SON signaling in LTE networks (while X2 messaging has been standardized, the response of the base station is a vendor implementation option). This makes interoperability between the small cell and macro cell layers questionable unless there is a commitment by equipment vendors to collaborate.

As the concept and definition of 'small cells' continues to evolve and expand to include different types of RF transceivers serving a mobile user, the means to manage and optimize the wireless network must keep pace. SON technologies are critical in unifying the different small cell nodes under a single umbrella to simplify the complex process of network optimization and management.

So, are small cells riding the hype cycle? Surely, if you expect volume deployments soon. But taking a long-term view, small cells are a catalyst to radically change the way operators deploy and manage networks as well as the way vendors design base stations. Regardless of the hype cycle, significant advancements are being made today that will define the radio access network of the future. In a way, it's a true revolution in the making.

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