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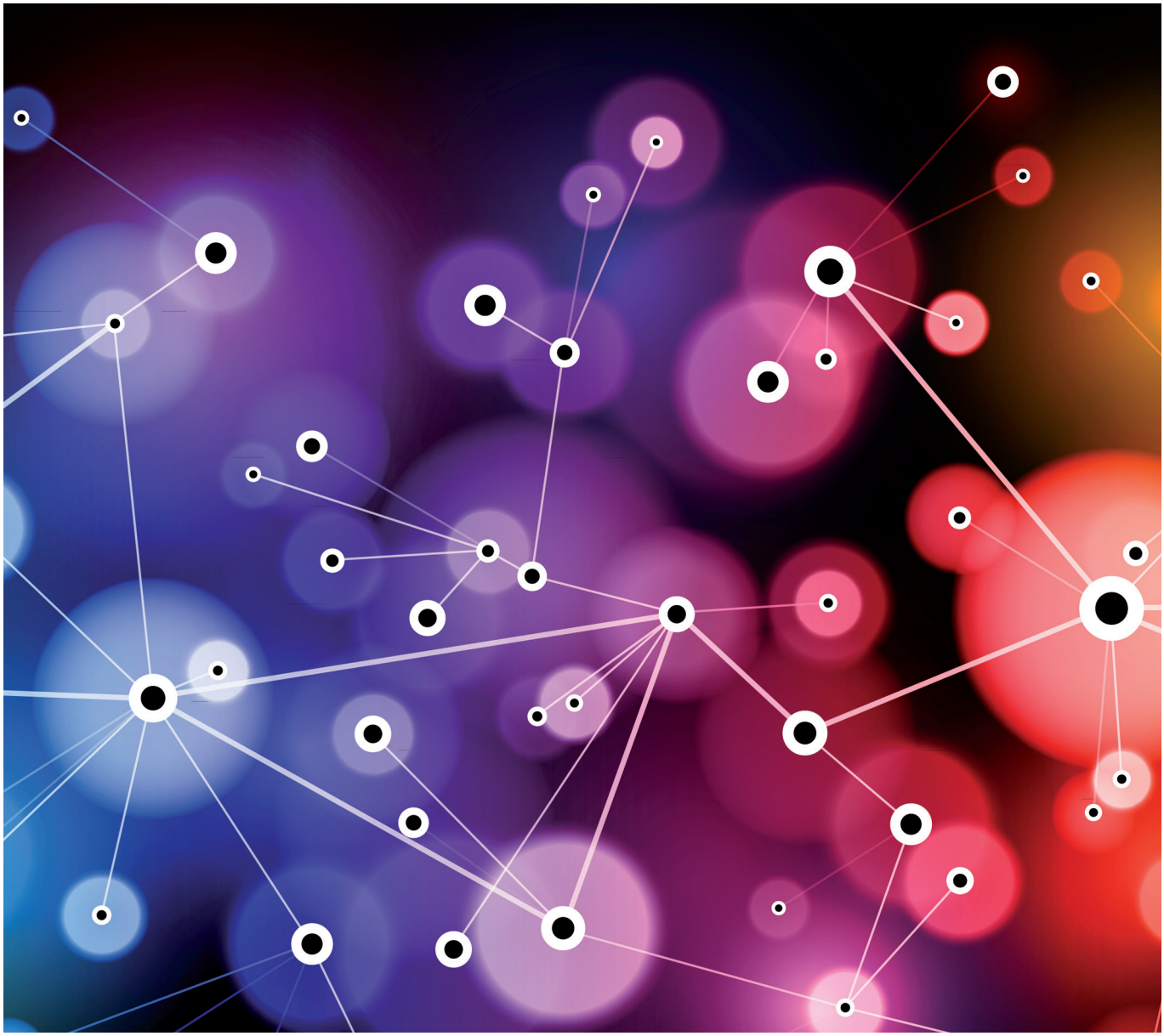
Smart Capacity Management in a HetNet World



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Getting the industry thinking

SYNOPSIS

In this powerful mobile age, consumers have learned to expect instant gratification. When mobile networks do not have the latest bells and whistles required to support the growing demand for more and faster data traffic, subscribers quickly lose confidence in their mobile operator's ability to provide network quality and keep up with the times. Mobile operators know what is required to grow and sustain their customer base - to provide data faster and deliver it seamlessly.

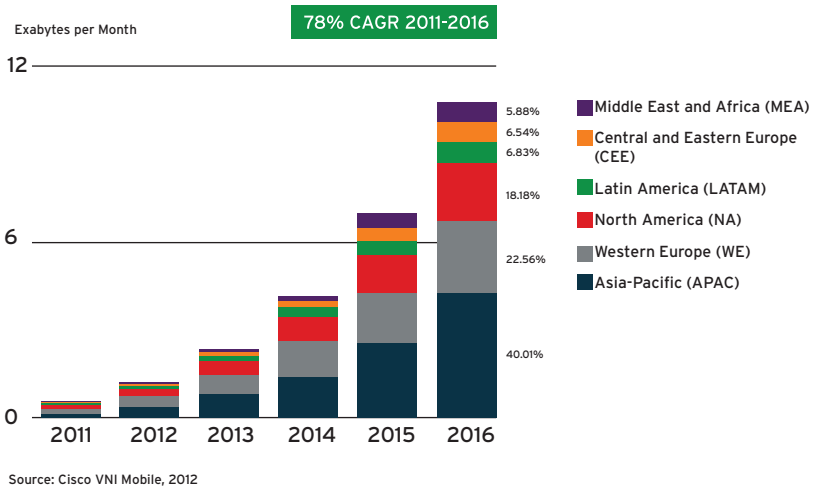
The question now is how to leverage current network assets while commissioning next generation technologies to support data demands without exhausting CAPEX and OPEX? Today's complex multi-vendor mobile networks include GSM, UMTS, LTE and HetNets (Heterogeneous Networks). Each mobile network is unique so there is no cookie cutter solution for a "quick fix". Network operators proceed with caution to maintain the delicate balance of meeting their customers' expectations, leveraging network assets, and exceeding network performance goals.

Capacity and coverage maximisation are pivotal elements in supporting our data-driven mobile world. Mobile operators need smart ways to enhance the subscriber experience through capacity maximisation while minimising CAPEX. This whitepaper will review smart ways to maximise network capacity and detail benefits to mobile network operators worldwide.

The Data Tsunami Challenge: Reality Tracks Predictions

All the predictions about the impending data tsunami have come to fruition for wireless operators worldwide. Global mobile data traffic grew 2.3-fold in 2011, more than doubling for the fourth year in a row. The 2011 mobile data traffic growth rate of 131 per cent was higher than anticipated. The global mobile data traffic for 2012 grew 133 per cent. Wireless operators are not only seeing a continued increase in data demands but are also challenged with effectively managing their network capacity and quality to cater to demanding subscribers.

Customer-focused operators are transitioning their subscriber base to 3G and 4G networks to ensure a better network experience in the most spectrally and operationally efficient manner. As a result, many operators expect the number of 2G only subscribers to decline over time. Over the next five years, many operators will focus their efforts on clearing and re-farming 2G spectrum, moving traffic to UMTS and/or LTE networks, and shifting valuable resources to newer technologies.



Source: Cisco VNI Mobile, 2012

Fundamental Approaches to Adding New Capacity

There are only four fundamental approaches to add network capacity. Each of the approaches is briefly explained below:

1. **Improving spectral efficiencies of existing networks** involves maximising existing 3G networks. This can be done through Self Organising Networks (SON) initiatives. This involves parameter optimisation (neighbours, handovers), load balancing (between the different cells of same or different technology layers) and changing site configurations to improve spectral efficiency. The main goal is to maximise the spectral efficiency (Kbps/MHz) of the existing network before augmenting the network with additional hard or soft capacity.

2. **Upgrade to newer spectrally efficient technologies** forces capacity maximisation of existing network resources. Improve spectral efficiency of existing spectrum and network resources by adding newer technologies such as LTE and LTE-Advanced (with higher modulation schemes) along with features [1] such as carrier aggregation, MIMO, SON and Beamforming.

3. **Augmenting capacity through new spectrum** requires capacity augmentation to meet the unmet traffic demand and further plan for growth. Augmentation could involve several initiatives such as adding new soft capacity, carriers and sub-sectorisation. The additional spectrum can either be obtained by the auction process or by clearing unused spectrum from legacy 2G technologies and re-farming for capacity growth either in 3G or 4G networks.

4. **Adding capacity through new cells (reusing available spectrum):** As observed by Cooper's law [2], spectrum reuse contributed to most of the large and disproportionate increases in overall wireless system capacity. This is because capacity in a wireless network is limited by the classic Shannon's limit as described by the Shannon-Hartley theorem. Beyond adding bandwidth and improving the overall quality of the network, the only other way for wireless systems to offer new capacity is through adding new cells. Adding small cells to form a HetNet will enable traffic offloading from the macrocells resulting in better throughput for both the small cell and macrocell users [3].

HetNets: Changing the Dynamics of Capacity Management for Wireless Operators

Many operators around the world are considering deploying HetNets to address capacity demands on their networks. The major driver for accelerating the deployment of HetNets is the belief that adding more cells in the form of Femtocells, Picocells, Metrocell and Microcells (collectively referred to as Small Cells as defined by the Small Cell Forum [4]) are the only way to keep pace with the tremendous growth in demand for wireless data. However, the task of planning and managing capacity in a HetNet scenario introduces new dynamics. Traditional network planning and optimisation involved only Macrocells. Now, with the need to add small cells on a large scale, there is considerable pressure on operators to target the right areas for capital planning while keeping up with the demand curve. Table 1 below highlights the differences in approaches between Macrocells and HetNets capacity management processes:

TABLE 1: COMPARISON OF CAPACITY MANAGEMENT APPROACHES: MACROCELLS VERSUS HETNETS

Aspect	Macrocells	HetNets (mainly small cells)
Capacity Metrics and KPI Analysis	Based on OSS counters only	In addition to OSS counters, includes Geo-located KPI analysis
Root Cause Analysis	Based on counters and configurations	Based on counters and configurations
Existing Capacity Maximisation	None to very sparse; some parameter optimisation, new RRM features	Maximise existing resources through Self Organised Networks (SON); load balancing, parameter optimisation, site configuration changes
Capacity Augmentation	Individual sectors blocking identification	Customer driven hotspots and capacity crunch area identification via Geo-located traffic and KPIs
New Cell Planning	Propagation planning tools at all phases – some form of Automatic Cell Planning tools (ACP)	Network based Geo-location for target area selection; playbook approach (i.e, number of small cells per given area dynamic); subsequent use of in-building or outdoor propagation planning tools wherever necessary

Capacity management for HetNet deployment requires a different approach than what most operators currently follow. Most operators will rely on new tools and approaches to fully maximise their existing 3G network potential and add new cells at the most appropriate locations for 3G and 4G network deployments. The next two sections detail the processes that operators can undertake to manage their capacity using Self-Organising Networks & network based geo-location measurements.

Self-Organising Networks: A Necessary Component in the HetNet initiative

Wireless operators will most likely introduce small cells in their 3G networks initially and later on LTE. Typical optimisation techniques available to manage networks will fall short of addressing several issues. Namely, the ability to successfully balance load between the macro cells and small cells on a dynamic basis will be lacking with traditional optimisation approaches. However, with SON, operators can manage their existing capacity effectively.

Balancing traffic: Between Macro and Small cells: This phase involves balancing load between 3G macro cell and 3G small cells. Since there are no interfaces similar to LTE X2 defined in 3G, the solution involves Centralised SON architecture. Depending on the integration method of the small cells (either through Iub or Iuh in 3G), Centralised SON can co-ordinate with any existing distributed SON available in the small cell feature set. Specifically, SON features here will help in tuning cell parameters (admission, power, handover) to ensure

enough traffic is captured on to the small cells and the macro cells are not heavily loaded.

Balancing traffic: Among Macro cells: Operators would want to utilise the new 4G networks to make them preferred cells over 3G for data transfer sessions (current LTE networks are capable of supporting only data sessions). In this scenario, 3G networks still support most of the voice calls. With SON features, operators can make sure that 3G macro cells are relieved of data transfers wherever possible allowing either small cells or LTE macro cells to carry most of the data.

Network Measurements Based Geo-location: A Key Component in the HetNet Initiative

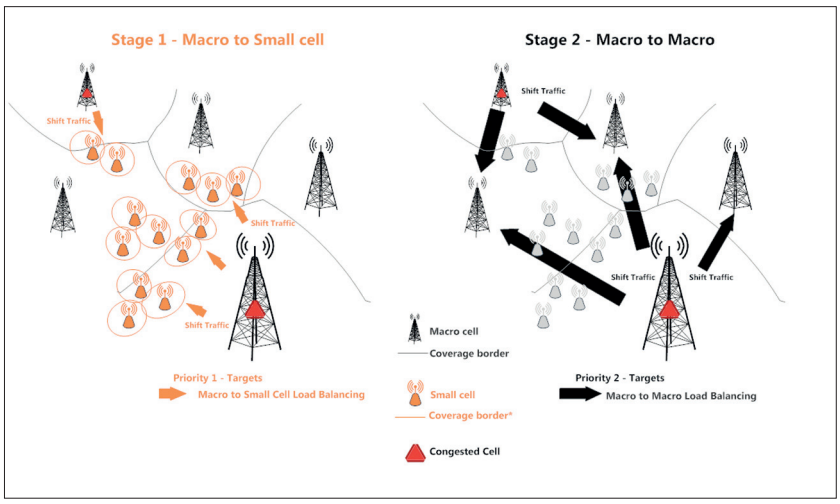
Typically, propagation planning tools are used in the early planning stages to define site locations and perform coverage analysis. However, using geo-located measurement data to identify traffic hotspots very quickly can speed up the planning process as the focus areas are defined very quickly. Furthermore, geo-located measurement data can also validate the output of the planning tools to address target area coverage and capacity aspects.

Geo-located Measurements - Visualisation and Analysis: The first step involves reviewing the various geo-located measurement plots obtained from a Geo tool such as COPS-Geo. Coverage and traffic related measurement plots enable engineers to quickly identify weak coverage areas and high traffic density areas. These areas can be tagged for further analysis.

Combined Geo, Network KPIs, and Configurations – Correlation Analysis: It is very critical to consider inputs from the current network KPIs and configurations for further analysis of sites identified for action (either for coverage or capacity). OSS counter based KPIs such as Accessibility, Retainability, and Throughput along with the site configurations and parameters should be considered for root cause analysis.

Initial Augmentation Site Plan- Review and Analysis: Coverage, Capacity, or both should undergo review to include all the adjacent sites in this final phase. The goal of this phase is to incorporate potential effects and benefits from existing site tuning, parameter optimisation and soft capacity enhancements. At the end of this phase, the existing site plan is revised either to delay or to add more sites to achieve the coverage and capacity objectives.

HETNET – LOAD BALANCING SON SCENARIOS



CASE STUDY: GEO-BASED HOT SPOT PLANNING AND VALIDATION OF SITE AUGMENTATION PLANS

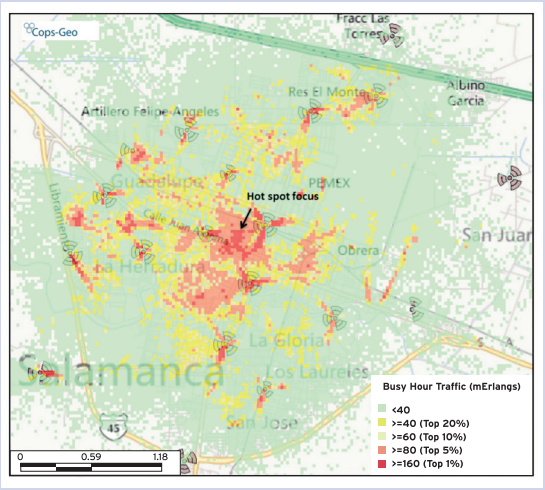


Figure 3: Geo-located traffic plot – busy hour

Objectives:

1) Identify hotpots for a selected region

2) Validate new UMTS site plans for a region by identifying the sites which can be eliminated from the existing plan based on the existing capacity and coverage needs in the area.

Methodology and assumptions: For hotspot identification, use percentile calculations on traffic to plot traffic density maps.

For validation of augmentation plans, perform analysis for regions with new site proposals. New location impacts are verified based on Geo-located RSCP, Ec/No coverage, Neighbour sites performance KPIs. The following guidelines were used to provide recommendations:

GUIDELINES TO VALIDATE AUGMENTATION PLANS

RSCP Coverage	Ec/No Coverage	Neighbours' Accessibility	Neighbours' Retainability	Recommendation
Greater than -75 dBm	Greater than -9 dB	Greater than 99.0%	Greater than 99.0%	Do not Augment; capacity and coverage can be maximised using existing sites
Between -75 to -85 dBm	Between -9 to -10 dB	Greater than 99.0%	Greater than 99.0%	Consider no augmentation; capacity and coverage can be maximised using existing sites
Between -75 to -85 dBm	Between -9 to -10 dB	Between 98.5% and 99.0%	Between 98.5% and 99.0%	Consider no augmentation; capacity and coverage can be maximised using existing sites
Less than -105 dBm	Less than -18 dBm	Less than 98.0%	Less than 98.0%	Augment with new sites

Results: Analysis showed that most of the newly proposed 3G sites are needed for coverage expansion. Therefore, only a small number of sites were planned due to capacity and network performance issues. The final recommendation is that the operator can delay or postpone augmenting 15 per cent of the sites because capacity and performance can be maximised by implementing various optimisation and load balancing methods such as Celcite's 2G Network Maximisation or 3G Grid Coverage services.

CONCLUSIONS

All the predictions about the impending data tsunami have come to fruition for wireless operators worldwide. Customer-focused operators are transitioning their subscriber base to 3G and 4G networks to better network experience in the most spectrally and operationally efficient manner. Beyond adding new bandwidth and improving the quality of the network, the only way for wireless systems to offer new capacity is through adding new cells. Adding small cells to form a HetNet will enable traffic offloading from the macrocells, resulting in better throughput for network subscribers. Most of the operators around the world are considering deploying HetNets to address capacity demands on their networks.

However, the task of designing and managing capacity in a HetNet scenario introduces new dynamics for capacity management. Most operators will rely on new tools and approaches to fully maximise their existing 3G network potential and add new cells at the most appropriate locations for 3G and 4G network deployments.

Using COPS-Geo geo-located measurement data to quickly identify traffic hotspots can speed up the planning process because the focus areas are defined immediately. Furthermore, geo-located measurement data can also be used to analyse target area coverage and capacity aspects. COPS-AIC provides correlation analysis using geo-location data, network KPIs and configurations. As a final step, geo-location based capacity and coverage analysis can help in validating the augmentation site plans and do sensitivity analysis resulting in a pragmatic cell augmentation plan. Celcite offers comprehensive Network Maximisation and 3G Coverage Grid Optimisation services to help with intelligent cell augementation plans.

Capacity and coverage maximisation are pivotal elements in supporting our data-driven mobile world. Mobile operators need smart solutions such as the closed loop COPS-SON load balancing product to enhance the subscriber experience through capacity maximisation while minimising CAPEX.

Celcite continues to help their clients achieve better than 70% improvement in engineering resource efficiencies, better network performance, enhanced customer satisfaction, and a higher ROI.

For more details about Celcite's powerful RAN management solutions, visit www.celcite.com.

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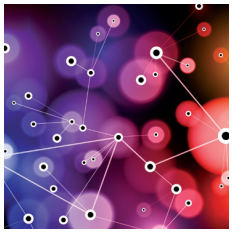

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ABOUT CELCITE

Celcite is the world's leading provider of SON and network management solutions for all mobile technologies including GSM, UMTS, LTE and HetNets. Celcite combines expert managed services and an innovative automation platform to help mobile network operators worldwide simplify network management and maximise network potential with less effort. The key ingredient in their complete network management solution is the ground-breaking COPS™ automation platform. Developed by Celcite, COPS™ provides an enterprise grade unified automation platform that monitors, manages, and mitigates network problems automatically. COPS manages and optimises nearly 2 million sectors using a single-click approach to find and resolve problems.

COPS™-Geo is a probe-less mobile terminal geo-location solution that provides comprehensive analysis for coverage and capacity optimisation. It also provides an innovative alternative to drive testing using geo-coded mobile measurement data to analyse wireless network data from the perspective of your customers. COPS-Geo will significantly improve your customer perceived network quality by providing insight into actual subscriber experience for both voice and data.

COPS™-SON is a dynamic solution for evolving networks. The solution operates on a number of data sources such as site data, performance counters and mobile measurements, delivering modifications to the network automatically. COPS-SON provides automatic remedial actions for improvement of radio resource management, Automatic Neighbour Relation (ANR), load balancing as well as cell outage compensation

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