P.I. WORKS

PERFORMANCE IMPROVEMENT

HotSpot Identification & HetNet Planning with uSON

Automated Smart Planning for Heterogeneous Networks

White Paper

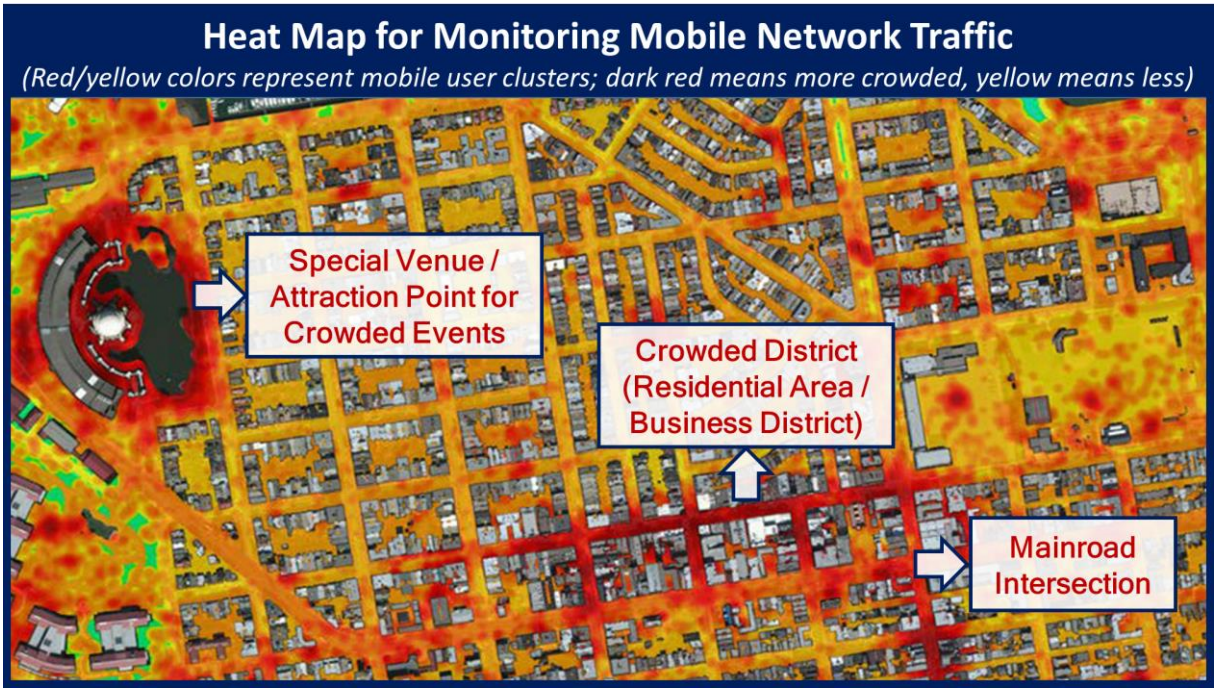
INTRODUCTION

Providing extensive coverage and improved capacity to a continuously growing and diverse mobile customer base at any location and any given time are the major challenges of every Mobile Network Operator (MNO). As a response to these challenges, MNOs are investing in solutions (such as small cells or femtocells) that will increase capacity and improve coverage both indoors and outdoors, so that the subscribers will experience a better Quality of Service (QoS). This approach is mostly suitable for urban areas and large public venues that drive mobile network traffic.

Expansion of the mobile network and deployment of new cells are increasing the network complexity, as a mix of radio access technologies and vendor equipment are being deployed into the network. As a result, network becomes more heterogeneous, and capacity planning, new site selection for small cell deployment, and successful interaction of small and macro cells require tedious planning and execution.

A thorough and well thought network and new site planning is a critical component of a successful network transformation strategy. To achieve this purpose, geo-located subscriber usage and mobility patterns need to be harvested and analyzed. As depicted below in Figure 1, a street-by-street view of the mobile usage patterns is shown on a heat map, so to understand where the major impact points (such as commercial zones or special venues) emerge and to identify the small cell (hotspot) deployment areas.

Figure 1, North American Outdoor Network Capacity and Coverage Demand



Source: SmallCell Forum, Capacity Planning for HetNets

Being easier to deploy than macro cells with lower site acquisition and installation costs, small cells present a viable option for providing the needed capacity and coverage in densely populated areas. The MNOs need to determine the most suitable locations for the new sites by using the data coming from

the existing sites along with the collection of correlated financial and fault management data. Different deployment scenarios need to be modeled and compared in terms of cost, effectiveness and return on investment (ROI) target to establish the best business case for the MNO.

P.I. Works, with years of industry experience, powerful software products and strong services capabilities, can help MNOs to identify hotspots and deploy the most relevant and suitable product combination. In this whitepaper, we briefly describe the methods to achieve optimum hotspot planning by using Small Cell / HetNet Planning module of P.I. Works' uSON Product Family, its flagship centralized SON solution, and its professional services.

NETWORK PLANNING AND DEPLOYMENT CHALLENGES

Although there are automated tools available to MNOs to perform various tasks in network planning and deployment, there are still many challenges encountered on a daily basis that need to be tackled. Every small cell deployment creates its own set of unique challenges pertaining to deployment locations and user profiles to be covered. However, there are common challenges faced during different phases of the deployment process. These are outlined below:

- **Balancing Cost and Quality:** The most suitable locations for small cells can include lamp posts, phone booths or building facades which can make deployment more intricate than originally planned. Determining the best site location for new cells is an important aspect in planning, as wrong site selection will lead to increased capital and operational expenditure (OpEx), more operational work and reduced mobile service quality.
- **Interference Management and Tuning:** Optimization of small cells include interference management between macro and micro layers, especially for co-channel deployments, as well as mobility parameter tuning for favoring small cells over macro cells where needed. When the number of small cells to be deployed is massive, the optimization of these cells is not an easy task and may require several iterations to achieve the best results.
- **Backhaul Capacity**: Small cell deployments need to ensure optimum use of network capacity, compensating for traffic increase, which can only be achieved by utilizing high capacity backhauls. Capacity deficits in the macro layer resulting from low spectral efficiency can be alleviated by deploying both co-channel or dedicated channel small cells with appropriate backhaul. In areas without appropriate backhaul infrastructure, small cell deployment is delayed or flawed.
- **Correlation of Various Data**: Selecting the best location for deployment requires correlation between user, network and financial data as well as backhaul capacity where possible. MNOs should factor in all the relevant data points in their analysis for small cell site selection, as otherwise the analysis would not be conclusive and might lead to wrong site selection. The more data that is correlated, the more optimum the selected locations would prove to be.

HIGH PRECISION HOTSPOT IDENTIFICATION FOR CELL PLANNING

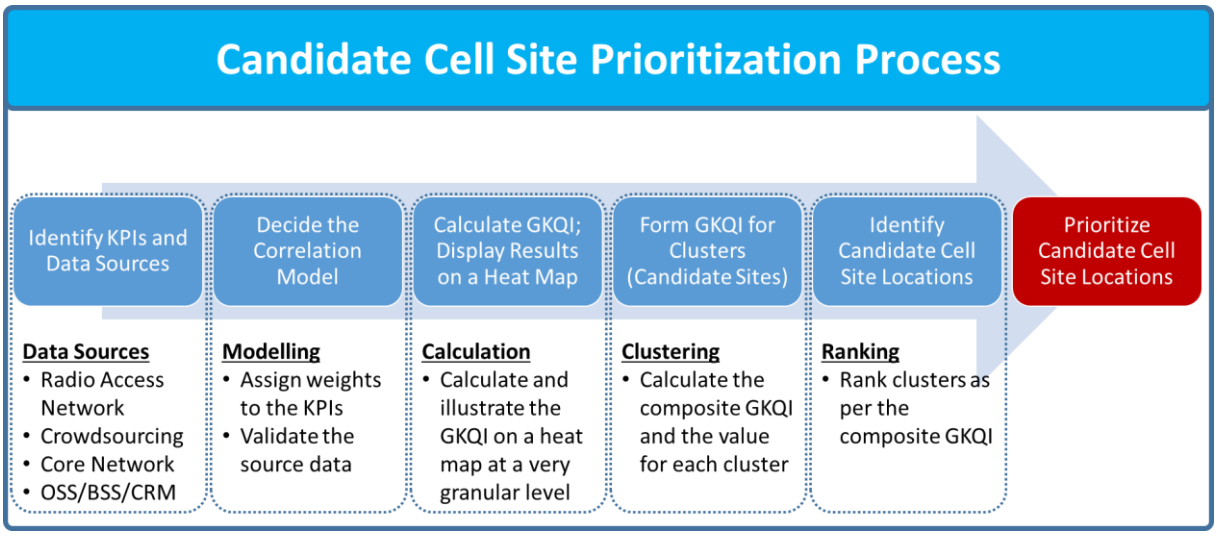
The main objective of cell planning is to find the optimum number of required base stations to increase the coverage and capacity and to achieve the desired KPIs (key performance indicators) such as accessibility. After the analysis of the value that can be offered by alternative sites, the most suitable locations and number of sites to be deployed need to be identified to minimize CapEx and OpEx.

In most cases, coverage gaps and capacity bottlenecks can easily be identified around certain hotspots typically near congested macro sites. Doing an initial analysis might yield a lot of different hotspots which are candidates for small cell deployment. The candidate locations need to be assessed to provide the most value when a small cell is installed at that location. The assessment needs to consider different metrics to calculate the best overall benefit for the new expense. In the sections below, we briefly describe the "Geolocated Key Quality Index (GKQI)", a metric that is used for valuing any specific geo-location in terms of its suitability for small cell deployment and macro cell offloading. GKQI is a key function of P.I. Works' uSON product and is used in HetNet Planning.

Geolocated Key Quality Indicator (GKQI)

P.I. Works applies a systematic approach to identify the ideal site locations, which requires use of complex algorithms to quantify the mobile service quality at a given location. As shown in figure 2, the process for a cell site starts with the identification of the KPIs.

Figure 2, Cell Site Selection and Prioritization Process for Small Cell Deployment



Source: P.I. Works

In network planning, experience shows that when more input dimensions are gathered for computation of quality metrics, the more precise and efficient the computed metrics prove to be. For this purpose, uSON gathers the following type of data to form the GKQI:

- **Radio Access Network Data**: Cell-Busy Hour Behavior, macro network utilization
- **Crowdsourced Data**: User application usage data
- **Core Network Data**: CDR (call detail record), probe information

- **OSS/BSS/CRM Data**: Cell based data such as revenue (from BSS), fiber lay out per cell site (from OSS), customer complaints (from CRM)

Crowdsourced data is correlated with macro network data and KPIs acquired from individual cells in radio access network. Any core network data that can be used such as CDRs or probe information is also used. Finally, for each point, any financial or customer related data, as well as information related to the current infrastructure of the site (e.g., availability of the fiber infrastructure) are also taken into account for revenue maximization and investment optimization. A bias weight is assigned to each KPI and then the GKQI is calculated.

The GKQIs are initially calculated per grid (on a heat map) from the KPIs obtained from cells serving those grids. Later on, the grids are compiled into clusters as it is more logical to work on cluster-level since grid granularity can be too high. Once the composite GKQI calculation is carried out on the clusters, they are sorted in descending order and filtered based on certain KPI thresholds that the MNOs monitor. The filters can also be used to apply priority conditions such as the number of complaints from VIP sites.

Finally, the most suitable locations (candidate cell sites) are provided which can immediately be used to proceed on the next site planning effort.

Prioritized Ranking of Ideal HotSpot Locations

The HotSpot candidate map is typically provided by the MNO as potential locations that will lead to superior mobile user experience and will materialize for revenue. These locations can be the areas which have relatively easy and cheap access to fiber backhaul, or locations where site acquisitions can be less costly. In either case, the MNOs might be tending to use a lot of small cells for new site planning; however ideally, the number of small cells to be deployed should also be minimized in order to reduce interference to the macro network and to neighboring small cells. The GKQI computation also has to take into account the proximity of the candidate locations when calculating the GKQI for each cluster (or how many candidate locations the cluster covers if the cluster size is big).

With the prioritization of the candidate cell sites, MNOs should agree on few alternative locations at first and deploy the small cells into these agreed sites for testing their impact on the network. Deploying new equipment to these areas will change the traffic pattern, and if the expected throughput is not observed at first, MNO will need to change the cell site and use other alternative locations for small cell deployment. Therefore, after the initial deployment, new data needs to be collected and assessed to identify the second set of locations, only if the network results are not satisfactory, and this process can go on iteratively until satisfactory results are obtained. More locations can also be suggested by lowering related KPI thresholds. This is for MNOs to decide as their priority in ranking KPIs or determining the thresholds for each KPI might vary from time to time or from one geographical location to the other.

Moreover, depending on seasonal network configuration changes in transmit power or antenna locations or changes in traffic patterns due to infrastructural advancement (i.e. new roads being built), hotspot locations might be changing frequently in accordance. This process also continues iteratively with new

cells being deployed and as new data from crowdsourced platforms or performance management systems becomes available.

Case Study: European Tier-1 Operator

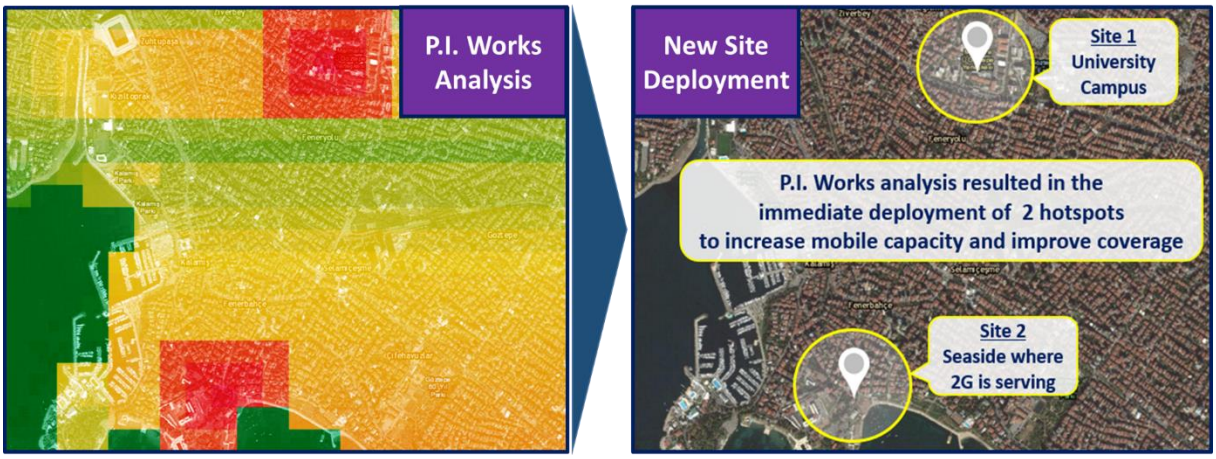
P.I. Works recently conducted a study on the 3G network of a European operator where the following inputs were used in the GKQI calculations:

- Best server cell and signal strength from radio planning tools (Radio access network data)
- Signal strength and traffic pattern (Crowdsourced data)
- Cell busy hour (CBH) power utilization, CBH code utilization and macro data volume (Radio access network data)
- Points of Interest (PoI) from site planning data (BSS data)
- Customer Complaints from CRM systems (CRM Data)

The aim was to identify the best site locations to maximize ROI while improving coverage quality and subscriber experience. In achieving this objective, the uSON used several steps to utilize the GKQI input, by first validating and normalizing the data, then weighting the data with respect to user defined importance levels and by computing clusters to collect different data points into meaningful regions to be utilized as hotspots. The search engine ranked and filtered the candidates with respect to planned locations and other considerations such as type of backhauling or revenue models.

The final result was an immediate deployment of 2 hotspots where the first one was on a busy university campus area whereas the other one was by the seaside where only 2G coverage was being provided. This new site was also shared with the already present 2G site, which resulted in cost optimization as the existing license from the available site was used.

Figure 3, Hotspot Deployment for the European Tier 1 Operator



Source: P.I. Works

Note: Red highlights indicated in the picture on the left show high network traffic where macro-cells that are serving the area are overloaded, indicating the need for the capacity extension.

CONCLUSION

In order to deliver superior services to a growing mobile subscriber base and to manage heterogeneous network environments more effectively, MNOs should establish solid network expansion strategy that leads to increased network capacity, better mobile coverage, and simplified management of the existing network resources.

P.I. Works uSON solution simplifies the network expansion process with a dedicated HotSpot Identification and HetNet Planning module, which can correlate a variety of data, including network KPIs, crowdsourced data from mobile devices as well as planning and financial data of MNOs. Using weights on bias metrics that can be configured easily on the GUI, best number of locations for new cell deployment can easily be identified.

The key benefits of the tool can be summarized as:

- High geographical precision for small cell planning at dense hot spot areas
- Better ROI on small cell investment through correlation of financial metrics
- Reduced cell edges and interference with macro layers by less small cell usages as only the minimum required number of locations can be pinpointed as opposed to general mass densification

New cell site identification and HetNet planning continues iteratively with the expansion of the mobile subscriber base and change in the mobile usage patterns. uSON's HotSpot Identification and HetNet Planning module with adaptive policies ensures that the ever changing needs of the mobile network is safely covered as well.

About P.I. Works

P.I. Works, is a leading provider of next-generation Radio Access Network (RAN) management solutions. P.I. Works' expertise in mobile network optimization, which spans over a decade, combined with the commercially available product portfolio and services, enables global Mobile Network Operators (MNOs) to improve network quality and subscriber experience, while increasing profitability.

To date, P.I. Works has deployed its solutions for more than 30 mobile network operators in 28 countries.

P.I. Works state-of-the art product portfolio, unified Self Organizing Networks (uSON), automates the optimization and operational tasks of complex mobile networks 24/7 to increase quality, capacity and coverage.

For more information, please visit http://www.piworks.net/ or send e-mail to sales@piworks.net.