DENSI FICATION OF MOBILE NETWORKS

The growth of mobile communication skyrocketed over the past decade in all parts of the globe due to pervasive utilization of smartphones and tablets. The growth in data usage of mobile applications and the usage of data services such as real-time video streaming, music, games, video chatting and social media along with the subscribers’ expectations of high service quality have pressured Mobile Network Operators (MNOs) for coverage and capacity expansion of their existing infrastructure. Moreover, digitization of business processes and growing adoption of IoT (Internet of Things) applications are also driving the demand for seamless and high-capacity mobile connectivity.

Network congestion due to capacity limitation frequently occurs in the crowded metro areas and commercial buildings where ubiquitous mobile Internet usage is higher than average and standard macro cell capacities can not fulfil the demand. The predictions from 2016 Global Mobile Economy report of GSMA reveals that the continuous growth of the mobile subscriber base and data traffic will cause MNOs to face severe capacity challenges. The report shows that number of mobile broadband connections will increase 71% from 2015 to 2020, whereas data traffic will grow 49% during the same period.

Figure 1, Global Mobile Economy Report 2016

As voice revenues of MNOs are in sharp decline as a result of OTT voice service utilization in the all IP network, maintaining quality of mobile broadband services will be of strategic importance for MNOs to drive further revenue. Slow-down in revenue growth, spectrum limitations, and higher cost-per-bit in traditional macro-networks drive MNOs to seek new, non-traditional ways of expanding capacity and increasing revenue. One such method to tackle the capacity expansion problem is the “network densification”, which is also regarded by most experts as the crucial step towards 5G evolution. In most
cases, network densification is achieved by small-cell deployments in hot spot zones as well as in areas with problematic radio coverage.

**CHALLENGES WITH SMALL CELL DENSIFICATION**

Despite having optimistic densification plans to solve capacity issues and to reduce cost-per-bit, the rollout of small-cells is not proceeding at the pace that it was originally planned for most MNOs as some of them announced significant delays in their deployment plans. A majority of deployment use cases are specific to residential or Small Office Home Office (SOHO) locations similar to traditional in-building solutions, which have limited mobility and less interference. They do not require complex network configuration and optimization, and do not fulfill the need for densification in urban locations.

There are various reasons that are holding MNOs back from mass small-cell deployments. Besides typical regulatory and site acquisition related challenges, many MNOs face various technical challenges such as tackling complicated network and traffic planning, including efficient mobility management, interference management between macro-cell and small-cell layers, and the need to provide backhaul to each small-cell location.

Other challenges that should be addressed for effective small-cell densification are briefly mentioned below.

- **Scalability**: Constructing Heterogeneous Networks (HetNets) involves many different components, often from multiple vendors, as well as multiple radio access technologies, which require major changes in deployment strategies and management dynamics. There is simply no magical tool or methodology to follow to make it “Plug and Play” as intended. With so many more cells being deployed in dispersed areas, which have different characteristics of RF propagation, traditional planning and post-launch optimization is not feasible anymore.

- **Interoperability**: To enable mass deployment, small-cells need to be treated as commodity equipment, allowing hybrid deployments of small-cells from various vendors in the same area. This requires good interoperability with the macro-cell vendors as well as between small-cell vendors. This interoperability requires parameter inconsistency management to ensure smooth and seamless handovers and consistent signal quality and throughput levels. According to the Small Cell Forum, a high number of optional features in the X2 interface specification is another problem, since different vendor’s X2 interface implementations may not be guaranteed to successfully interoperate within a multivendor environment.

- **Management**: One of the major challenges of using small-cells in the outdoor environment is implementing unified configuration and performance management functionality to ensure that subscriber experience does not degrade due to configuration inconsistencies, mobility characteristics, and lack of coordination in the operation of small-cells. While traditional macro-cell deployments usually include rich functionality in the Element Management Systems (EMS), small cells do have the same capabilities in their EMS. This results in very inefficient operation of small-cells in large scale deployments. It causes operational costs to increase, since more detailed manual intervention is needed with increasing number of deployed cells.
SOLVING DEPLOYMENT CHALLENGES WITH P.I. WORKS USON™ SOLUTION

Recently, MNOs started to favor Centralized SON (C-SON) solutions to ensure quick and less labor-intensive configuration, management and optimization of their mobile networks, especially in a multi-vendor and multi-technology environment. While Distributed SON (D-SON) functionality can provide automation to a certain extent, real field deployments show that D-SON alone cannot encompass the whole set of complex layer management strategies and policies that may differ from region to region depending on carrier configuration, available spectrum and traffic management heuristics. Additionally, some of the common optimization and operations use cases, such as Coverage and Capacity Optimization (CCO), cannot simply be implemented in a distributed manner, requiring centralized planning and operation. With the growing demand, C-SON solutions have evolved from supporting a simple set of optimization and configuration use-cases to adopting a full-scale network management convergence layer. P.I. Works uSON, the award-winning centralized SON solution, was designed with the requirements of complex HetNet management leveraging P.I. Works worldwide radio frequency (RF) optimization experience.

Optimizing the Entire HetNet with Centralized Policy and Rule Management

The uSON solution is designed to manage the mobile network as whole in a centralized manner, providing an abstraction layer from the actual implementation that is specific to vendor, radio access technology or spectrum layer. This type of abstraction allows MNO staff to manage policies and rules in the HetNet environment in a very fast and unified manner, greatly reducing the operational costs and eliminating management complexities. MNO’s layer management strategies in the HetNet environment can be implemented to command different management systems of various vendors and radio access technologies (RATs). The uSON solution manages small-cells by acting as their EMS. As a result, time spent on network management is also greatly reduced, since system operators previously worked on 3-4 different types of systems for collecting complex information from multiple sources to generate different types of manual change requests.
One of the key strengths of P.I. Works uSON solution for hybrid and heterogeneous networks is its ability to enable a completely seamless operation and management of the network, when macro and small cells from multiple vendors co-exist in the same geographical location. P.I. Works uSON solution, which is integrated with all of the major macro and small cell vendors, provides the MNOs with a clear overall picture of the network, and applies automated vendor and site specific rules for network optimization. A different set of rules from different profiles can be applied, such as modifying electrical tilt on the macro cells of vendor A or applying power modifications on the small cells of vendor B.
Enterprise Small Cell Management System

One of the major issues limiting massive small-cell deployment is the lack of good enterprise-grade management solutions. Most small-cell management systems are quite limited in the functionality provided. These systems usually provide only basic operations and limited performance management functions. Some small cell systems don’t even have a management system implemented at all. This requires other Element Management Systems (EMS) to directly interact with the small cells of these systems for any configuration and management purposes. P.I. Works uSON solution, with a Plug and Play adapter system, new cell planning and automatic small cell handling modules, easily addresses the challenges of small cell management, providing a central management ability to easily deploy and operate low-cost small-cells.

Orchestration of D-SON policies

Lack of standardization in the internal implementation of distributed SON functionality leads to poor interoperability of these functions across vendor borders. The D-SON system provided by an eNodeB equipment vendor will not easily work with another vendor’s eNodeB. This results in significant coordination problems across the multivendor LTE network. P.I. Works uSON solution orchestrates the D-SON implementations across multiple vendors providing a true hybrid SON implementation. This eliminates D-SON interoperability issues, which is one of the major inhibitors of low-cost small cell deployment.

Methods of orchestration include complementing the operation of D-SON algorithms as in the case of Complementary ANR (cANR), where uSON deletes the redundant neighbors from the NRT (Neighbor Relations Table) of the eNBs with respect to different conditions such as HandOver success rates. Another orchestration method is D-SON policy tuning as in the case of Mobility Robustness Optimization (MRO), where uSON controls the parameters of distributed MRO, such as optimization cycle, handover activity threshold or ping pong related thresholds.

Figure 3, Co-existence of P.I. Works uSON™ with D-SON

Source: P.I. Works

Note: CCO: Coverage and Capacity Optimization; RSI Opt: Root Sequence Index; Physical Cell Identity Optimization; ES: Energy Saving; cMRO: Centralized Mobility Robustness Optimization; cANR: Complementary Automatic Neighbor Relations; dANR: Distributed Automatic Neighbor Relations; dMRO: Distributed Mobility Robustness Optimization
Open SON Application Programming Interface (API)

MNOs need flexibility in managing their policies, as working with a fixed set of rules might not fit all requirements in a dynamic environment. For example, Automatic Inconsistency Correction (AIC) settings are always tuned per project, since the golden parameter settings for each MNO and the managed vendors may greatly differ. Hence, the C-SON solutions should be flexible enough to define new policies, to integrate with new interfaces and even to construct new algorithms when required to realize specific needs. P.I. Works uSON solution provides a complete Open API, which provides a simple integration to the in-house developed or 3rd party provided planning and optimization tools. Ready-to-use APIs supporting multiple programming languages allow MNOs to easily build in-house SON use cases and algorithms using the uSON solution. This provides an opportunity for proven methodologies to persist on the operator domain while also allowing a mixture of algorithms to be balanced out and easily adapted to different systems.

CONCLUSION

Densification with mass small-cell deployment is inevitable due to increasing capacity demands and spectrum limitations. The significant challenges such as interoperability between vendors, management, complexity, and scalability of traditional methods of operation are strongly impacting the rapid deployments of outdoor small-cells.

P.I. Works uSON is an industry-leading centralized SON solution, which was designed from the beginning with the goal to solve the problems related to densification on a massive scale in the evolution towards 5G networks. uSON provides the following functionality for small cell densification:

- Unified and converged HetNet Policy Management
- Seamless operation and management of the network
- Enterprise-grade management solution for small cells
- Orchestration of vendor distributed SON functionality
- Providing an Open API for integration to external tools or customer-built functions

MNOs with a vision to improve mobile network performance and subscriber experience should identify urban areas where major capacity challenges exist and prioritize new small cell deployment sites accordingly. Working with the right solution provider that offers centralized and automated planning, policy management and optimization capabilities for heterogeneous networks will result in significant operational efficiency gains as well as increased subscriber ARPU. P.I. Works offers uSON to help its customers successfully execute their network densification strategies.
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.