BUILD A SUPERIOR CUSTOMER EXPERIENCE AROUND SMALL CELLS

REDUCE COSTS, BOOST CUSTOMER LOYALTY AND INCREASE ARPU WITH SOLUTIONS THAT STREAMLINE SMALL CELL OPERATIONS AND IMPROVE CUSTOMER CARE

STRATEGIC WHITE PAPER

Small cell technologies bring network operators new opportunities to address surging mobile data traffic, increasing indoor mobile device use and growing expectations relative to quality of experience (QoE). However, small cells also bring new levels of complexity to network deployment, operations and maintenance processes.

To seize the small cell opportunity, operators need solutions that can take cost and complexity out of the network while delivering the superior QoE that enterprise and residential customers demand. On the operations side, this calls for solutions that can manage devices and services, handle diverse access technologies and work effectively in multivendor networks. On the customer side, it calls for solutions that can sustain a high QoE by supporting better and more proactive customer care.

TABLE OF CONTENTS

INTRODUCTION

Mobile users are consuming more data than ever, but network operator revenues have failed to keep pace. The growing gap between mobile traffic and mobile revenue has operators searching for solutions that will allow them to plan and utilize their network deployments more efficiently.

The current technology evolution path may not support prevailing traffic trends. Today, mobile data traffic growth stems mainly from residential and enterprise users who use their devices indoors. Studies by Informa, Infonetics and ABI Research show that more than 50 percent of voice and 70 percent of data traffic now originates from indoors. With in-building use, firmly entrenched and mobile data traffic is expected to grow tenfold in the next few years; the need for efficiency will become even more pressing for network operators.

Comprehensive network coverage has become critical to network operators and end users alike. Insufficient or unreliable coverage diminishes quality of experience (QoE) and can lead to churn or non-defect device returns. Operators must deliver robust coverage to support the growing demand for capacity and deliver a superior customer experience. Such coverage solution must take into consideration newly deployed small cells and already existing (legacy) Wi-Fi networks to ensure robust coverage. To this end, seamless convergence between different devices and technologies is a critical aspect to enhance customer experience.

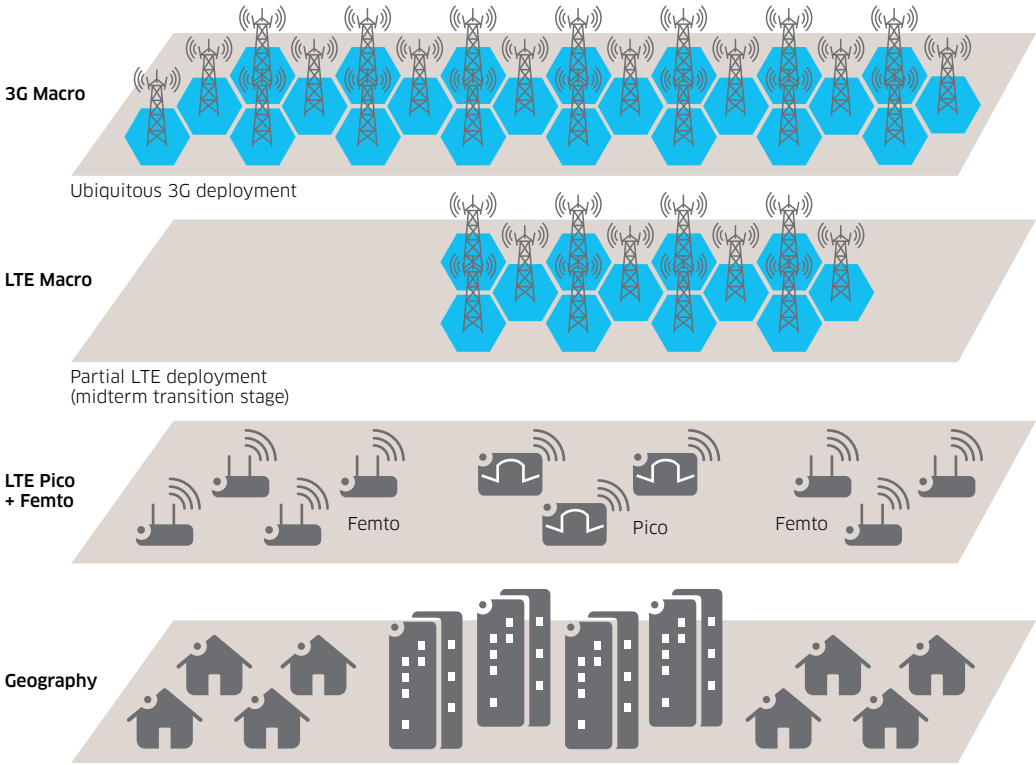
Small cell technologies offer the potential to address challenges relating to growing mobile traffic, indoor use and customer expectations. To realize this potential, network operators need management solutions that can handle the added complexity that small cells bring to the network while ensuring that subscribers get the superior QoE they now expect. These solutions will need to provide device and service management capabilities that can handle many different small cell technologies and operate efficiently in multi-vendor networks. Perhaps most importantly, these solutions will need to enable network operators to provide better customer care to subscribers and make it easy for them to get the help they need.

USING SMALL CELLS TO ADDRESS MOBILE DATA GROWTH

Macrocell-based mobile networks cannot provide good coverage and capacity in indoor environments. The construction materials in old and new buildings severely attenuate radio signals, and the sometimes densely wooded areas around these buildings hinder signal penetration. Mobile customers are not getting reliable service from macrocell-only networks.

The introduction of small cells enabled network operators to make the Heterogeneous Network (HetNet) model a reality. The HetNet model uses a layered approach that combines small cells with macrocells and other access technologies such as Wi-Fi (Figure 1). This approach helps network operators address the challenges involved in extending coverage and capacity to all users, particularly indoor users.

Figure 1. The HetNet layers access technologies to provide better coverage to users everywhere



A small cell is a low-power cell that can provide public or private access to nearby residential or enterprise users. Nanocells (range ~200m) and picocells (~50m) provide public access in places like offices, shopping malls, train stations or airplanes. Femtocells and Wi-Fi (~10 m) provide private access in homes and businesses. Residential and enterprise femtocells should operate with high reliability and fidelity and support broadband services through a variety of communication technologies, including mobile (W-CDMA, LTE) and, in some cases, wireless (Wi-Fi). Any optimization solution for small cells must take into consideration already existing Wi-Fi networks in order to enable seamless customer experience across different devices and technologies.

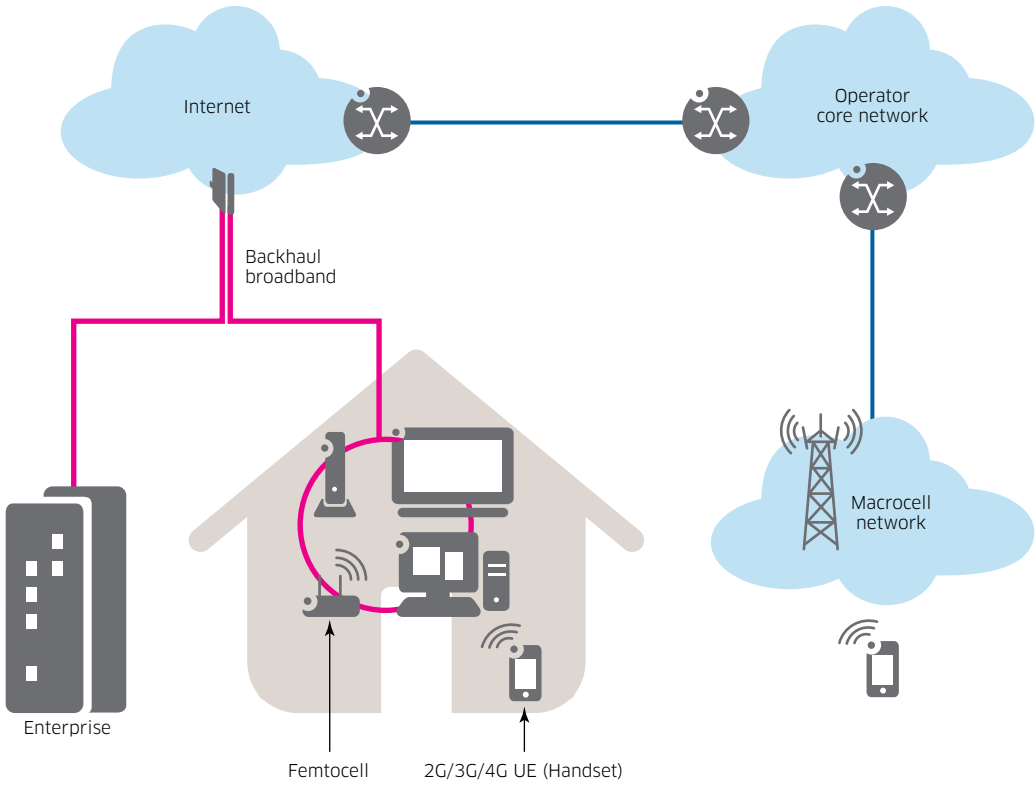
Femtocells support fixed-to-mobile convergence that can deliver the high QoE that residential and enterprise customers demand. They shorten the distance between the device and the user, serve smaller numbers of users and use a lower transmit power to reduce interference with neighboring cells. Some femtocells also support multi-technology (both licensed LTE and unlicensed Wi-Fi or LTE) air interfaces. For end users, access to femtocells brings a more satisfying, higher-quality mobile broadband service experience.

The small cell layer is designed to carry broadband data and offload traffic from the 3G or 4G macro layer. As more enterprises and consumers set their sights on 4G, many operators are considering a direct transition to 4G without deploying a 3G layer in their networks.

SMALL CELLS BRING NEW OPPORTUNITIES AND CHALLENGES

Although they may support the same technologies, small cells and macro cells require different levels of performance. The lower performance requirements for small cells make them a more cost-effective choice for large network deployments. However, the large number of small cells required for large networks adds a layer of complexity for service providers. The current challenge for service providers is to find solutions that can manage increasingly complex networks and deliver a consistently high QoE to customers. This challenge will evolve as HetNets become more common. Network operators will need the ability to simultaneously manage devices, services and multi-layer networks. Devices capable of supporting multiple access technologies present network operators with opportunities to position themselves as service providers and bring rich multimedia content close to subscribers (Figure 2). To seize these opportunities, operators will need indoor small cell solutions that can manage devices and services and ensure that they contribute to a positive customer experience.

Figure 2. Indoor small cell architecture



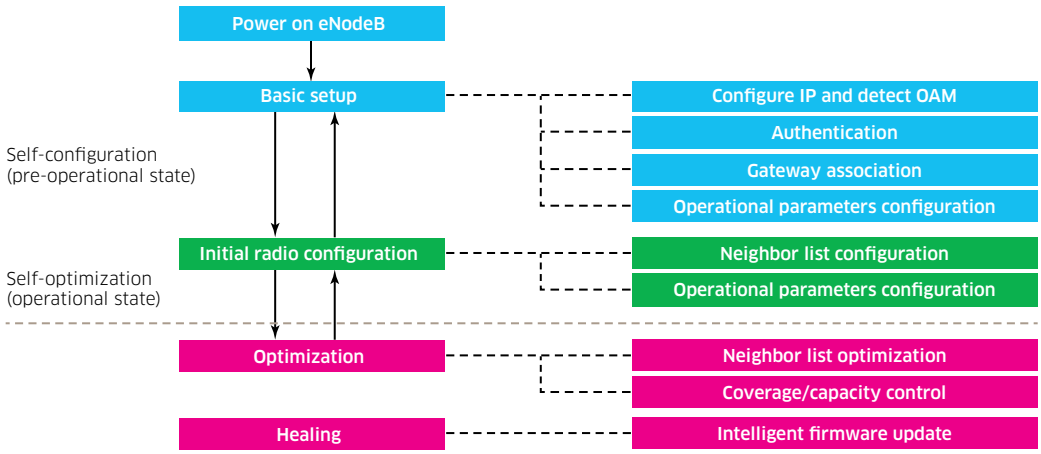
Operators with large networks are attracted by the low deployment costs associated with small cells. However, prospective deployment cost savings can be offset by the diverse technology, device and service requirements they encounter in managing residential and enterprise small cells. Table 1 shows sample operations and maintenance requirements for the three most popular indoor access technologies. The degree of difficulty involved in developing an efficient HetNet management strategy is illustrated by the fact that operators and customers assume responsibility for maintenance and operations for different cell types.

Table 1. Maintenance and operations for different cell types

	Femtocell	Wi-Fi	Picocell
Users	Residential: 4-8 Small enterprise: 16-64	Residential: 4-8	Large enterprise: 64-128
Site rental	Customer	Customer	Operator/owner
Installation	Customer	Customer	Operator
Electricity bill	Customer	Customer	Operator/owner
Radio planning	No (local)	No	Yes (prior and global)
Backhaul	Via customer	Via customer	Dedicated
Macrocell interaction	Not yet available	Not applicable	Yes
Tx power	<23 dBm	20 dBm	23-30 dBm
Access rights	Mainly closed	Closed	Public
Handover	Possible	Vertical	Yes
Mobility	Low	Low	Medium high
Channel	Static	Semi-static	Fast fading
Peak speed (2x2 MIMO)	75 Mbps/10 MHz 150 Mbps/20 MHz	Standard dependent: 5,700 Mbps/20-60 MHz	75 Mbps/10 MHz 150 Mbps/20 MHz

To support a HetNet, an operator must deploy, configure and manage the operations of many small cells. Efficient network management is crucial. The self-organizing network (SON) concept addresses this need by offering a means to optimize access network performance. As defined by the 3rd Generation Partnership Project (3GPP), SON solutions provide self-configuration, self-optimization and self-healing functions that proactively keep the network running smoothly without manual intervention. Figure 3 provides an overview of the key SON functions.

Figure 3. Self-organizing network functions



Operators can choose from three SON architecture models. The first is a centralized model, where SON functions are executed from a SON server. The second is a distributed model, where SON functions are executed at the device. The third is a hybrid model, where some SON functions are autonomously executed at the device and some are executed on a centralized server.

A centralized SON gives network operators sufficient control of network operations. The network self-configuration function enables operators to plan and deploy networks quickly and manage inventory efficiently. Self-configuration also helps operators simplify the provisioning of femtocell devices, which are much more complex than residential

Wi-Fi devices or set-top-boxes, zero touch provisioning is essential for ensuring successful network configuration and deployment and avoiding help desk calls. Zero touch provisioning also allows femto devices to scan their macro and femto neighbors and automatically create a list of good neighbor cells. Users can be handed over to these neighbor cells if necessary.

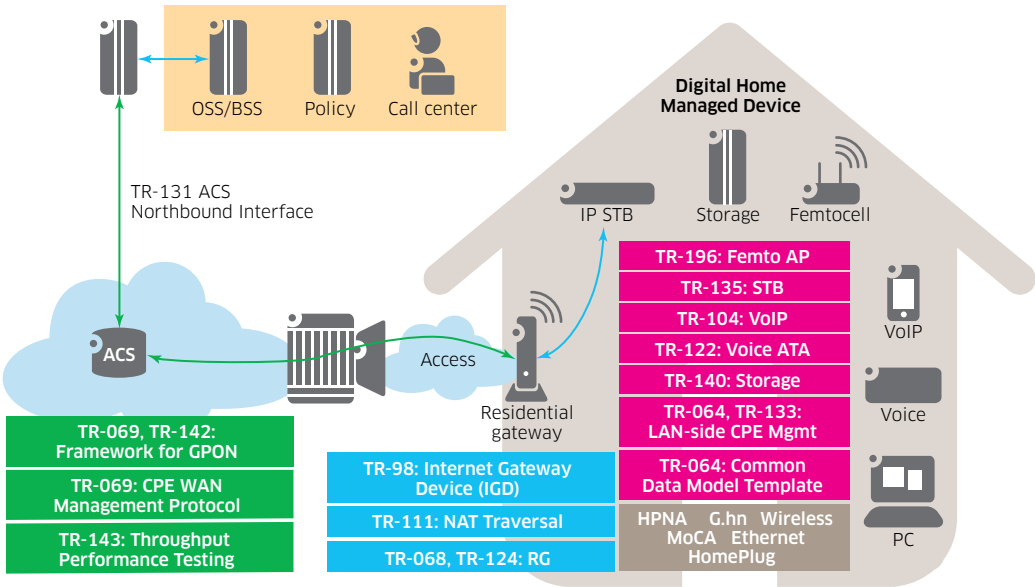
The self-optimization and self-healing functions of SON can help operators overcome the challenges and complexities inherent in HetNet operations. For instance, the complex software stack used for femtocells demands intelligent software updates that can limit or eliminate service downtime and sustain a positive customer experience. The proactive self-healing capabilities of SON can allow operators to address these demands. In addition, physical cell identity (PCI) assignments must be planned with care to avoid non-optimal PCI combinations for adjacent cells. Self-optimization allows operators to automate these and other complex network operations to minimize PCI collisions during the operations phase.

The functions and methods enabled by SON focus on optimizing network performance. They do not consider actual customer requirements. Operators seeking to enrich the customer experience need to complement small cell and SON capabilities with more active customer care.

BUILDING TOWARD SMALL CELL STANDARDS

Most residential and enterprise small cell deployments use equipment and proprietary algorithms from a variety of vendors. The need to manage these multivendor networks is a new challenge for operators. This challenge is heightened by the growing need to extend a superior QoE to customers who use their devices indoors. With the remote management TR-069 technical reports (Figure 4), Broadband Forum has begun taking steps to establish standards that can be used to allow interoperability within multivendor small cell networks.

Figure 4. Broadband Forum home network standards



Broadband Forum's standardization efforts have targeted the cost-effective deployment of residential and enterprise small cells. The primary output of these efforts is the remote management functions defined in the TR-196 and TR-262 technical reports. These functions will be essential for supporting multivendor interoperability and management in indoor deployments, where many equipment vendors — far more than for macrocell deployments — are expected to compete for business.

DELIVERING A SUPERIOR SMALL CELL EXPERIENCE

Indoor small cell deployments will support smaller numbers of users but will also need to provide a very high QoE. The ability to deliver a superior customer experience in indoor locations is vital for any operator seeking to retain current customers, add new customers in the future or increase average revenue per user (ARPU). The challenge for operators is to find and adopt solutions that can concurrently enhance network performance and customer QoE.

Enhancing network performance

Small cell deployments demand solutions that can bring intelligence to device management and provide a rich platform for multivendor residential and enterprise small cell deployments. The most effective solutions will offer network operators a new range of advanced features, including:

- **Automated service provisioning**: The small cell provisioning process flow typically varies based on the operator's network and preferences. It is also influenced by the capabilities of each vendor's small cells. Operators need a flexible and configurable provisioning engine that can consider their requirements and multivendor device capabilities and take advantage of their value-added services. During provisioning, the management system may need to configure small cell, core network, OSS/BSS and service parameters. Automated workflow engines will allow operators to ensure that the right parameters are configured across the entire service and network ecosystem.
- **Configuration, diagnostics and troubleshooting**: Enterprise small cells may interact with each other and with overlaying macro cells. Large enterprise networks are typically structured based on criteria such as locations, departments and departmental groups. Factors like floor plans and building materials can make it difficult for mobile phones to communicate with the cells that serve a given office. The interaction between small cells and already existing Wi-Fi network should be foreseen and consequently, small cells optimization with respect to Wi-Fi resources is an important task. Such optimization approach takes into consideration already existing Wi-Fi networks and enables seamless customer experience.

  Network operators can address these challenges with solutions that can provide different configuration profiles for different locations, sites and groups. A rich data model and software development kit (SDK) can give an operator the flexibility to plan the right small cell deployment for any enterprise. One-to-one diagnostics capabilities will allow the operator to retrieve useful information about the status of a given subscriber's device and push updated configurations and repairs directly to the device.
- **Performance and fault management**: Network operators need fault management capabilities that define alarm types and rules that can then be customized for specific devices and services. Proactive device and service monitoring capabilities will allow operators to automatically detect issues and take action to improve service quality and reliability. Proactive collection and analysis of performance and error statistics data from devices will allow operators to take action to enhance network performance.

- **Location-based services**: Location-based services are essential small cell functions. Emergency services personnel need to know the exact location of the calling user so that they can direct police, ambulance and fire services to the right place. Small cell management solutions should allow operators to configure each device to identify the area, county, city and country in which it is deployed. Operators should also have access to SDKs that allow them to query an individual device's location, check the device's position relative to the desired location, determine if the device has moved to another location, and configure the device's parameters based on its location.
- **Small cell management console**: Operators can benefit from solutions that provide insights and guidance relative to small cell deployment, operations and maintenance. For example, an effective management console could help operators visualize complex residential or enterprise deployments and determine where best to place small cells. It could also help them identify and locate faulty devices and take action to upgrade reboot or re-provision devices when necessary. The management view extends to existing Wi-Fi networks.

Enhancing the customer experience

Enterprise and residential customers have increasingly high expectations relative to mobile services. They expect to have good coverage and capacity no matter where they go, indoors or out. If problems arise, customers expect that the network operator will address and solve them quickly, with little or no disruption to their services or QoE. Of course, an extended management view on both small cells and already existing Wi-Fi network is a right way to optimize the customer experience in residential and enterprise deployments.

If network operators are to live up to these expectations, they will need solutions that enable support personnel to quickly and easily diagnose the root causes of small cell issues and provide simple and effective customer care. Self-service consoles and mobile apps are essential: They will reduce support calls and increase customer satisfaction by allowing users to manage their own devices proactively. Ideally, these solutions will be supported by functions that can collect performance and call data from small cells, and run algorithms on the server to enhance the customer experience.

Centralized customer experience solutions can be supported with data management platforms (DMPs) that collect and aggregate relevant supporting data prior to executing functions. Some device vendors already provide proprietary on-device SON functions that target network performance. Solutions that leverage emerging standards will be better positioned to take advantage of each vendor's strengths and provide supervisory functions that can configure and drive algorithms on different devices.

Operators will benefit from centralized solutions that can extend data aggregation and monitoring capabilities across multiple cells. Solutions that can work with and optimize functions across different access technologies will allow operators to ensure that users enjoy the best possible QoE. Solutions that have the flexibility to operate with multivendor OSS/BSS environments will have the potential to provide the data transformations, protocol translations and function abstractions required to optimize a HetNet environment.

CONCLUSION

The most effective small cell management solutions will be those that focus on the total quality of experience provided to users. Solutions that can use standards and SON functions to self-configure and optimize devices and provide self-healing capabilities will help network operators streamline OAM processes. Such optimization approach must take into consideration already existing Wi-Fi networks and enable seamless customer experience. However, these solutions will not make any difference to subscribers unless they address and reduce subscribers' pain points. Similarly, they will not make any difference to operators unless they can help minimize cost, increase ARPU and spur subscriber base growth.

To make a meaningful difference, small cell solutions must allow operators to reduce their operational and capital expenditure and provide proactive care to subscribers. Solutions with multivendor device and OSS integration capabilities will enable operators to reduce total cost of ownership by giving them the freedom to design end-to-end solutions based on Broadband Forum, Small Cell Forum and 3GPP standards. Those built with flexibility and scalability in mind will allow operators to easily plan, design and implement residential or enterprise small cell deployments in multitenant scenarios. Solutions that can run in a virtualized (cloud) environment will simplify deployment, accelerate service customization, and launch processes.

ABBREVIATIONS

3G	Third generation
3GPP	3rd Generation Partnership Project
4G	Fourth generation
BSS	Business support system
CAPEX	Capital expenditure
dBm	Decibel-milliwatt
DMP	Data management platform
eNB	E-UTRAN Node B or Evolved Node B
GW	Gateway
HetNet	Heterogeneous network
HPNA	HomePNA Alliance
IP	Internet Protocol
IPsec	Internet Protocol security
LBS	Location-based service
LTE	Long-Term Evolution
Mbps	Megabits per second
MHz	Megahertz
MIMO	Multiple-input and multiple-output
MoCA	Multimedia over Coax Alliance
NL	Neighbor List
OAM	Operations, administration and management
OPEX	Operational expenditure
OSS	Operations support system
PCI	Physical cell identity
SCOPE	Small cell orchestration and provisioning engine
SDK	Software development kit
SON	Self-organizing network
SW	Software
TCO	Total cost of ownership
Tx	Transmission
W-CDMA	Wideband Code Division Multiple Access

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