Cisco Licensed Small Cell Solution: Reduce Costs, Improve Coverage and Capacity
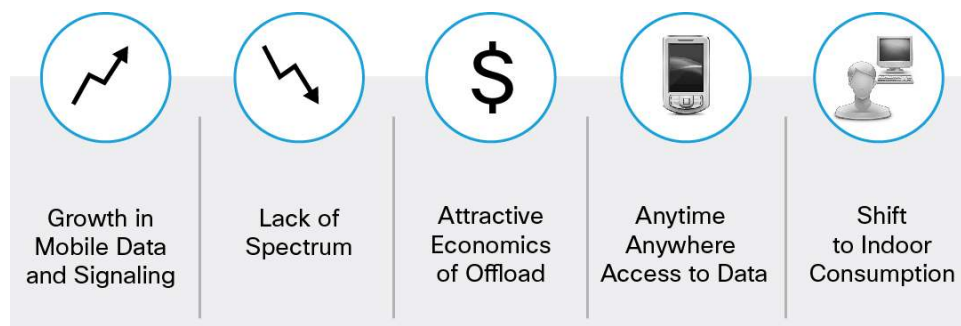
The Cisco® Licensed Small Cell Solution is designed to address the challenge of mobile service coverage and to expand network capacity. Small cells extend voice and data services to mobile subscribers while offloading traffic from the macro network. Additionally, Cisco Small Cell capabilities are uniquely used to deploy consumer services that are based on indoor location and presence and new enterprise services such as integration with enterprise voice systems and access to local enterprise networks.

The Cisco Licensed Small Cell Solution represents what we've learned from our extensive experience deploying residential femtocells, implementing scalable carrier backhaul and rolling out Cisco Service Provider Wi-Fi to a rapidly growing base of customers. This experience has enabled Cisco to deliver a comprehensive solution that addresses the real-world challenges of small cell deployments. Among the challenges we've addressed are interference management, network security, broadband backhaul requirements, access control, zero-touch provisioning, and mobility. The Cisco Licensed Small Cell Solution is fully deployable today and complies with the small cell architecture and interfaces as defined in the 3GPP standards, delivering unprecedented Quality of Experience (QoE).

Market Trends

Several trends in the market are causing operators to incorporate small cell solutions into their network infrastructure plans (Figure 1).

Figure 1.   Small Cell Market Trends

Growth in Mobile Data and Signaling | Lack of Spectrum | Attractive Economics of Offload | Anytime Anywhere Access to Data | Shift to Indoor Consumption

- Cisco Visual Networking Index shows that operators can expect mobile data traffic to increase 13-fold over the 5 years between 2012 and 2017. Analysts also point to the exponential growth in signaling traffic helping to promote the data growth.

- Coupled with this growth in traffic is the lack of available new spectrum and the difficulty for operators to quickly and cost-effectively add new macro cell sites. In this environment, small cell solutions become very attractive.

- Distinctions between consumer and business services on mobile devices have become blurred. Small cells can help deliver those services transparently across third- and fourth-generation (3G and 4G) cellular networks and Wi-Fi.

- Wireless usage is shifting indoors. Network analytics show that the majority of mobile data usage - close to 80 percent - is indoor and nomadic, rather than truly mobile. Macro networks were built for voice on the go. Small cell networks are designed to address modern mobile data traffic patterns.

- Small cells offer new monetization opportunities by taking advantage of the intelligence inherent in the network, including policy, hyperlocation, context, application, and device information. Businesses can use this information to engage with their customers in new ways, including through augmented experiences, location-based content, and personalized loyalty programs.

With the increased demands on the network, operators are investing in small cell solutions to help optimize consumer and business services on mobile devices across 3G, 4G, and Wi-Fi networks. These small cell solutions can provide efficient connectivity and coverage for all users. Small cells are low-powered indoor and outdoor radio base stations that operate in both licensed and unlicensed spectrum, have a limited range serving a limited number of users, and are managed by an operator to provide a transparent experience between enterprise and consumer services. Small cells are expected to increase the overall capacity of the mobile network and deliver the same, and in some cases more, bandwidth as macro cells.

Evolving from our market-leading Service Provider Wi-Fi, Femtocell, and Mobile Backhaul solutions, this overview covers the Cisco Licensed Small Cell Solution.

Improve and Enhance End-User Services

Deploying small cells will allow mobile operators to improve their service value proposition. This is first realized by simply enhancing indoor coverage, which improves the user experience for all of the mobile services consumed in-building. All of the mobile data services, including those requiring high throughput, will be available (for example, high-definition streaming and live video).

Secondly and more interestingly, small cells offer the possibility to define new services that will only be available when the users are under small cell coverage. These new services rely on the ability to detect that the user has arrived at home, in the office, or in a public venue. The following are some examples of new services under consideration.

Femtozone Services
These correspond to standard mobile data and voice services but are triggered when the phone comes in range of the small cell. This could include services such as:

- Automatic profile switch when entering home (for example, moving from business to personal services)

- Short Message Service (SMS) alert when a family member comes home

- Application triggering with a state change (for example, linking with Facebook)

Connected Home Services

These services are linked to local breakout capabilities that will enable the small cell to locally route traffic within the home network. This brings two additional benefits. First, it allows the operator to offload that traffic from the mobile core network. Secondly, the mobile handset can then become a true component of the mobile home network per the connected home standards (for example, those for a media player or media server). Examples of connected home services include:

- Backup of mobile hosted content (music or pictures) to the home PC
- Playing videos or slide shows from the phone to another element
- Transforming the phone into a remote control for other elements

Enterprise Services

A set of enterprise services are also being developed that will allow integration of home small cell services with enterprise services. The main benefit is that any user will be able to access those services without needing any specific client on their phone. Moreover, the architecture will help to ensure optimum user experience with full coverage and mobility. Examples of enterprise services include:

- Integration of mobile handsets with the enterprise PBX dial plan and services
- Local access to the enterprise LAN.

Cisco Licensed Small Cell Solution Overview

Cisco applies architectural innovation to mobile networking, transforming small cells into a platform for business and service innovation. Cisco delivers the industry's only proven small cell solution for both optimization and monetization.

Cisco Licensed Small Cell Solutions are easy to deploy, innovative, and proven across the globe.

- Frictionless deployment: Cisco offers operational ease by applying network intelligence that is based on years of design and implementation expertise. From radio performance to policy and management to backhaul, we design simplicity into our solution to keep operators' costs down and mobile users satisfied.
- Innovation for business results: Cisco is guiding the market toward a unified and scalable standards-based licensed and unlicensed architecture for wireless service delivery, meeting the needs that result from the dramatic increases in consumer capacity requirements. On top of this we add analytic tools that operators use not only to monitor the network, but to monetize the network, allowing operators to unlock new business models.
- Real-world heterogeneous networking: We deliver standards-based self-organizing network (SON) technology, not just for fully integrated heterogeneous 3G, 4G, and Wi-Fi networks, but also for multivendor network deployments. Our solution provides an elastic, flexible architecture of infrastructure and software with intelligence.

Cisco offers more than products; we offer an easily deployed solution. We have a dedicated Advanced Services team that is experienced in delivering large commercial small cell solutions. To help service providers deploy the solutions efficiently and successfully, Cisco offers professional services for custom design, implementation, integration, and support of the small cell network. With this approach, Cisco is in a unique position to help operators go to market quickly with new and enhanced small cell services.

Cisco Licensed Small Cell Architecture

The Cisco Licensed Small Cell Solution is an end-to-end architecture. The primary elements depicted in Figure 2 are:

- Enterprise and home small cells
- Small cell gateway
- Management and provisioning
- Small cell backhaul

Figure 2.   Cisco Small Cell Solution
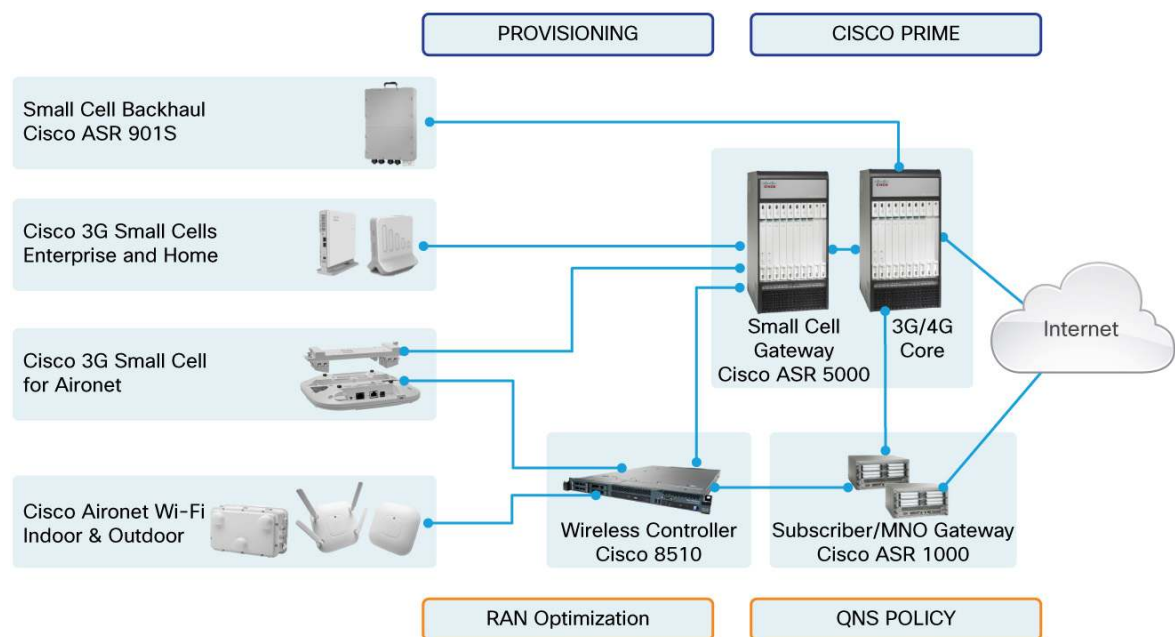
Enterprise and Home Small Cells

Cisco offers a portfolio of licensed small cells for the home and office to support multiple deployment environments and technologies. All Cisco small cells are standards-based and operate as the Home Node B (HNB) in the network as defined by the 3GPP Release 8 femtocell architecture. Cisco small cells are fully managed by the mobile operator, so the network is secure and controlled.

Cisco 3G Femtocell

With over a million deployed, the Cisco 3G Femtocell is our flagship small cell for the home. The Cisco 3G Femtocell is an in-building mini cell tower designed for ease of use by the end-user. It carries the 3G signal inside a home or small office, providing cellular voice and data service for up to four simultaneous callers within a coverage area of up to 5000 square feet. It connects to the network by a cable or DSL network, so traffic can be offloaded onto the fixed broadband network. The Cisco 3G Femtocell is optimized for low-cost, low-capacity 3G processing for IP-based backhaul.

Cisco 3G Small Cell

The Cisco 3G Small Cell (Figure 3) is a self-contained small cell base station that can be quickly and easily deployed to enterprise locations. The 3G Small Cell delivers mobile operators a rapid and cost-effective deployment solution for increasing coverage and capacity, creating a new platform for mobile broadband services.

Figure 3.   Cisco 3G Small Cell

The Cisco 3G Small Cell generates a high-quality 3G signal inside offices, shops, and public spaces, using broadband backhaul for rapid deployment and low-cost operation. The 3G Small Cell delivers high performance, 3G coverage indoors to enhance the mobile user experience, while allowing operators to significantly reduce infrastructure costs. It supports bidirectional handover with the macro network and operates in open access mode so all customers in the office or shop can get the benefit of improved coverage and fast data speeds.

Cisco 3G Small Cell Module for Cisco Aironet

The Cisco 3G Small Cell Module (Figure 4) takes advantage of the flexible modular design of the award-winning Cisco Aironet® 3600 Wi-Fi access point to offer mobile operators a rapid-to-deploy licensed radio network extension on the footprint of their Cisco SP Wi-Fi solution, creating a new platform for mobile broadband services.

Figure 4.   Cisco 3G Small Cell Module for Cisco Aironet

Three key challenges face mobile operators interested in deploying licensed small cells: where to hang them, how to power them, and how to backhaul the traffic. Cisco solves these problems with innovation. Building on the Cisco Aironet heritage of robust, award-winning Wi-Fi access point design, the 3600 Series delivers extreme flexibility with its modular configuration. The 3G Small Cell Module for Cisco Aironet is the first licensed radio module to take advantage of this flexibility by delivering a fully integrated, high-performance, low-cost 3G small cell for voice, data, and messaging services.

Portfolio Advantages

Cisco's small cell portfolio offers the following advantages.

- Increased mobile network capacity and coverage indoors, where it is most needed. Usage reports show that up to 80 percent of mobile traffic today occurs indoors and while people are stationary.
- Reduced network costs and operations. By having a self-contained small cell radio, mobile operators have the ability to quickly and easily deploy either with a desktop-mounted solution or a wall-mounted solution. And by integrating the 3G Small Cell Module into the Aironet 3600 Series, network, power, and operating costs are dramatically reduced.
- The capacity to install, power up, and go with zero-touch configuration. There are no extra steps required to enable Cisco small cells to run in a Dynamic Host Configuration Protocol (DHCP) environment. This approach can quickly provide 3G coverage to end users.
- Self-optimization based on back-end network intelligence for easily managing millions of devices so they do not cause interference with neighboring femtocells, picocells, and macro cell towers.
- Secure, carrier-grade 3G base station technology. Cisco small cells provide the technology equivalent of an in-building mini cell tower. The device is secure and fully managed by the mobile operator to provide for 3G signals inside an office or enterprise.
- Standards-based technology. A Cisco small cell operates as a HNB in the standard 3GPP architecture for small cells and is connected to the network with the specified Iuh interface. This architecture provides for rapid deployment and multivendor interoperability.

Cisco ASR 5000 Series Small Cell Gateway

The Cisco ASR 5000 Series Small Cell Gateway is an integral element in both the Cisco SP Wi-Fi Solution and the Cisco Licensed Small Cell Solution. The Cisco Small Cell Gateway gives subscribers easy access as they transparently roam between 3G, 4G, licensed, and unlicensed small cell networks.

The Cisco Small Cell Gateway (Figure 5) provides high-capacity, intelligent HNB gateway (HNB-GW) functionality as specified in 3GPP Releases 8 and 9, in both the interfaces towards the HNB (Iuh) as well as towards the 3G core network (Iu-cs and Iu-ps over IP and ATM). This standards compliance helps to ensure smooth network integration.

Figure 5. Cisco ASR 5000 Small Cell Gateway

The Cisco ASR 5000 has a unique hardware and software architecture that is ideally designed for the HNB-GW application and is capable of connecting millions of 3G Universal Mobile Telecommunications System (UMTS) small cells to the core network. The Cisco solution is 100 percent standards-based, on a single platform that scales to millions of small cell subscribers in a single chassis, for a low total cost of ownership.

The Cisco ASR 5000 Small Cell Gateway includes IP Security (IPSec) termination capabilities so that it can be deployed as an integrated Security Gateway (SeGW) and HNB-GW. The HNB can be authenticated using Extensible Authentication Protocol - Authentication and Key Agreement (EAP-AKA) or using certificates as inserted into the HNB typically during the manufacturing process. In case of EAPSIM/AKA, Cisco can also offer a specific AAA server (Cisco Access Registar) that interfaces directly with the existing Home Location Register (HLR) over MAP/M3UA. The Cisco ASR 5000 SeGW supports the standard IPSec/Internet Key Exchange (IKE) v2 procedures with standard security profile (ciphering and integrity) to set up the secure communication between the HNB and the network.

Small Cell Backhaul: Cisco ASR 901S

For residential and enterprise small cell deployments, the backhaul of traffic is easily managed by existing broadband networks. Where small cell backhaul can be a challenge is in outdoor metropolitan environments where broadband networks may not be easily accessible. Cisco has solved this problem by bringing intelligent routing out to the pole where small cells are being deployed.

Cisco took our market-leading cell-site router, the ASR 901, and ruggedized it for use in the harshest outdoor environments. The Cisco ASR 901S Series Aggregation Services Router (Figure 6) features a flexible architecture that supports "any-G" from any vendor, and dramatically reduces operating costs through zero-touch provisioning capabilities and extensive management tools.

Figure 6. Cisco ASR 901S Series Aggregation Services Router

The Cisco ASR 901S Series is optimized for the backhaul of true multivendor heterogeneous small cell networks. The ASR 901S is a compact, environmentally hardened, low-power-consumption router that can be installed in the outside plant without an enclosure. The router can be easily deployed in challenging locations such as lampposts, telephone poles, and sides of walls. By using the Cisco ASR 901S, operators can reduce backhaul operating costs, simplify deployment and provisioning, and enhance their profit opportunities with premium mobile and Ethernet services.

The ASR 901S platform provides unique Cisco value to the small cell backhaul market:

- Flexible architecture that supports true multivendor "any-G" heterogeneous radio technology and backhaul topologies
- Dramatically reduced operating expenses (OpEx) and TCO through zero-touch provisioning capabilities and extensive management tools
- Unsurpassed user experience through Cisco's best-in-class routing and comprehensive end-to-end operations, administration, and maintenance (OAM) capabilities

Cisco Quantum Radio Access Network Optimization

The size and complexity of multivendor heterogeneous networks necessitates SON technology and the move to live and automatic optimization in the radio access portion of the network. Cisco Quantum RAN Optimization addresses this pressing need, allowing service providers to maintain control and benefit from major network investment savings for both OpEx and CapEx.

Cisco Quantum RAN Optimization is an automated control plane that provides real-time, dynamic performance and capacity optimization for mobile networks. Some of the features include:

- Automatic neighbor relations: Monitors connections between cell sites and automatically adjusts neighbor lists for subscriber handoff to help ensure overloaded cells are bypassed and unused cells are removed from neighbor lists to reduce OpEx

- Load balancing: Shifts traffic between cells, based on availability, congestion, and blocking of radio resources, so that traffic within a cluster of cell sites is evenly balanced across all access technologies

Management and Provisioning

The Cisco Licensed Small Cell Solution has been specifically designed to meet management requirements for successful small cell deployment, including fault management, performance management, and achieving true zero-touch provisioning. Cisco also provides custom integration with existing operational support system (OSS) and network management system (NMS) networks, a requirement for managing ongoing operational costs.

The Cisco Licensed Small Cell Solution integrates management and provisioning components into our end-to-end architecture for transparent performance. Figure 7 provides a detailed view of the components involved. The Small Cell Remote Management System deals with provisioning and element management and Small Cell Service Assurance provides overall alarm and performance management for the end-to-end architecture.

Figure 7. Cisco Small Cell NMS Layer
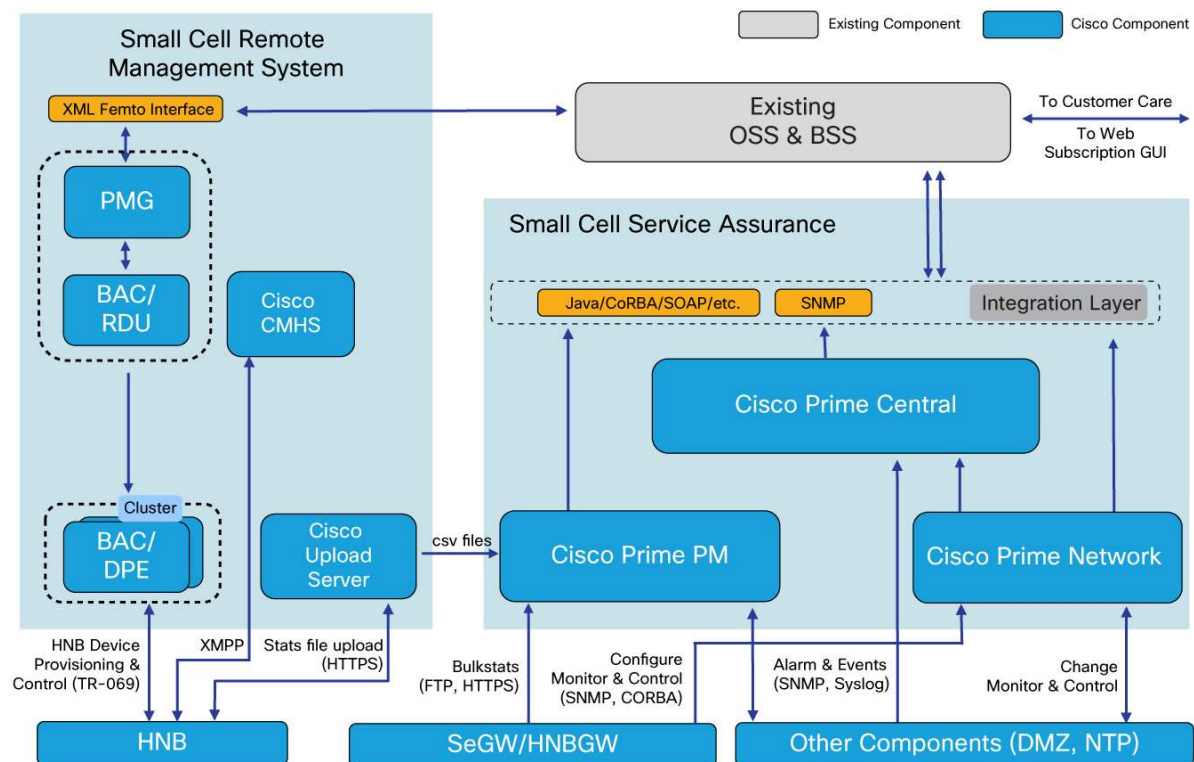
It is worth noting that the OAM layer is where the most integration is required with an operator's existing OSS/business support system (BSS) systems, and some of the elements may already available in some forms in the deployed network. The Cisco solution can easily be adapted to support the current network requirements. Cisco Broadband Access Center (BAC), Regional Distribution Unit (RDU), Device Provisioning Engine (DPE), Femtocell RAN Manager (FRM) and Provisioning and Management Gateway (PMG) are UNIX-based software applications and can be deployed on standard hardware. All applications have been developed to provide high performance and 1:1 redundancy.

Small Cell Remote Management System

Cisco Broadband Access Center

Cisco Broadband Access Center (BAC) is a distributed and scalable application that automates the tasks of provisioning and managing home and enterprise small cells on a mass scale. It delivers secure provisioning and management by using the TR-069 and TR-196 specifications as defined by the Broadband Forum. Cisco BAC 3.5 builds on the core BAC architecture and provides functions specific to small cell management. The application scales to support networks of almost any size and offers high availability, made possible by its distributed architecture with centralized management. Cisco BAC is a proven platform that supports millions of customer devices today.

Cisco BAC serves as the TR-069 Auto Configuration Server (ACS) for HNBs. Its functions encompass registration, location verification, activation, status reporting, firmware upgrade, configuration update, and remote troubleshooting. Cisco BAC incorporates RDU and DPE servers, which are geographically distributed and redundant. The DPEs interface with HNBs using the TR-069 protocol. The RDU interfaces with the mobile operator's OSS through the PMG.

Cisco Provisioning and Management Gateway

The Cisco Provisioning and Management Gateway (PMG) provides a platform for small cell activation workflows and interfaces to the service provider OSS/BSS. The standard workflows and interfaces are readily customizable to accommodate any unique operator systems. It includes a simple XML/HTTP API that can be used to accomplish small cell preregistration, subscription changes, grouping of devices, location notifications, activation notifications, retrieval of live small cell status, device reboot, service block and unblock, and whitelist maintenance.

The PMG also includes a database containing RAN and RF data used for zero-touch activation and SON flows. This database typically contains information about geographic areas that represent different RF environments or management domains and all the necessary RAN and RF data. This data allows the PMG to automatically assign small cells to their appropriate security gateway, regional gateway, management servers, and management groups so that they can be configured with appropriate candidate frequencies by UTRA Absolute Radio Frequency Channel Number (UARFCN), primary scrambling code (PSC), and location access code (LAC) and routing access code (RAC) candidates. The database also provides for proper assignment of unique over-the-air and billing identifiers.

This is accompanied by a set of tools that allow administrators to make bulk changes and roll them out in a controlled and coordinated fashion. For example, if an additional HNB-GW is introduced in the area, the FRM provides the tools to rebalance HNBs in the area across two gateways. Customer service representatives can also see live information about the customer's small cell for diagnosing issues from within their existing customer support systems and can make changes such as editing the access control list and suspending the small cell remotely.

Cisco Management Heartbeat Server

The Cisco Management Heartbeat Server (CMHS) provides functions that are not effectively covered by the TR-069 protocol. Using Extensible Messaging and Presence Protocol (XMPP), the CMHS maintains a persistent connection with every small cell for active status monitoring. This technology takes advantage of Cisco experience with mass-scale chat, messaging, and collaboration servers and allows CMHS to perform the following functions:

- Real-time status reporting for all small cells

- History of small cell status

- Monitoring of small cell connectivity through ongoing heartbeats

- Status profiling by groups of indicator values

- Notifications about key indicator changes

- Connection requests for TR-069 session over Network Address Translation (NAT)

A single CMHS instance can scale to 250,000 small cells.

Small Cell Service Assurance: Cisco Prime

Small cell service assurance is provided by three elements of Cisco Prime™: Cisco Prime Network, Cisco Prime Performance Manager, and Cisco Prime Central.

Cisco Prime Network

Cisco Prime Network provides real-time discovery of network elements, configurations, and services. With Cisco Prime Network, network operators can visualize dynamically discovered virtual connections through topology displays and navigate through corresponding device configurations. Cisco Prime Network eliminates the need for manual inventories and configuration tracking. Real-time understanding of network element configuration combined with the Cisco Prime Network event provides rapid insight to the likely root cause of ASR 5000 and sever errors, which in turn promotes rapid diagnosis and mean time to repair.

Cisco Prime Performance Manager

Cisco Prime Performance Manager is a performance monitoring extension of Cisco Prime Network for the HNB and the HNB-GW. Cisco Prime Performance Manager is an easy-to-deploy and easy-to-use solution for gathering and reporting performance statistics, even in multivendor networks. Cisco Prime Performance Manager gives actionable information that spans core, aggregation, and access networks, with a comprehensive set of prepackaged reports. Cisco Prime Performance Manager transparently integrates with Cisco Prime Network, providing operators with visibility into network key performance indicators (KPIs). The combined solution provides both post-event fault management and information to proactively avoid future disruptions.

Cisco Prime Central

Cisco Prime Central is a common umbrella manager for fault monitoring. Prime Central collects event fault data issued by the BAC for the HNB or issued by Prime Network for the HNB-GW. As an umbrella manager it also provides a single unified and integrated interface for all the Prime components and optimizes the navigation across the various modules.

Cisco Services

Mobile operators can realize the full value of the Cisco Licensed Small Cell Solution with professional and technical services from Cisco together with our partners. We can help mitigate risk, accelerate time to market for new revenue-generating services, and improve the end-customer's experience.

Cisco Services has unparalleled experience and expertise implementing large commercial small cell deployments, and integrating systems and network services. We help operators speed time-to-value and resolve issues quickly using specialized tools, best practices, a collaborative delivery model, and an extensive global support infrastructure.

As operators plan, build, and manage the Cisco Licensed Small Cell Solution, we promote success through a lifecycle approach customized to specific needs. Software-enabled smart service capabilities provide better visibility, better information, and better understanding at every stage.

- **Plan**: Create an agile infrastructure and cost-effective strategy with service capabilities ranging from architectural consulting to detailed design.
- **Build**: Speed time to value and reduce deployment risks through solution validation, solution integration and deployment, and migration support. Validate that the solution meets requirements through specialized labs for small cell interoperability testing and system verification testing.
- **Manage**: Improve performance, availability, and resiliency; reduce costs through service offerings that provide better network insight, help improve network inventory management and health, and identify and mitigate potential problems before they can affect the network.

Why Cisco?

Operators worldwide are choosing Cisco to take full advantage of the enormous opportunities available in the small cell marketplace. We provide a carrier-grade, end-to-end solution, and can help operators deliver standards-based transparent mobility and the differentiated user experience that customers are asking for as they use their mobile devices to move between consumer and business environments. We have a channel to market for premise-based deployments, with tens of thousands of trusted partners built over years of enterprise deployments.

Cisco Small Cell Solutions provide more flexibility than other platforms on the market, allowing operators to use a single architecture to target the widest range of licensed and unlicensed small cell opportunities and implement flexible business models, while gaining efficiencies that improve profitability and productivity. Cisco can help service providers cost-effectively deploy a network extension from an existing intelligent network infrastructure to deliver small cell services today and prepare for the next generation of revenue-generating home and enterprise services. Cisco is dedicated to industry standards, and actively participates in the key industry bodies that are defining the small cell standards, including 3GPP, the Small Cell Forum, Digital Living Network Alliance (DLNA), and the Broadband Forum. We contribute recommendations, incorporate standards compliance into our development cycles, and support new releases as they are defined.

Summary

The Cisco Licensed Small Cell Solution offers increased network intelligence and performance to help operators:

- Deliver high-bandwidth applications to indoor locations from an indoor location
- Meet today's increasing bandwidth demand at dramatically lower costs
- Break the small cell backhaul bottleneck with ruggedized cell-site routers

The end-to-end Cisco Licensed Small Cell Solution:

- Delivers comprehensive security, exceptional scalability, and fast time to market
- Is autoprovisioned and uses existing handsets for improved voice and data coverage
- Is standards-based for real-world heterogeneous networking

For More Information

For more information about the Cisco Small Cell Solutions, visit http://www.cisco.com/go/smallcell or contact your local Cisco account representative.