

Small Cell Solutions

SOLUTION BRIEF

For many years, the mobile industry has been in handwringing mode over rising mobile broadband demand. Hair-raising forecasts about increasing indoor traffic demands and numbers of connected devices are nothing new. The story of network densification through small cells is well told and most of the solutions are expected offerings from expected suppliers. But as **wireless traffic continues to grow at greater than 60% per year, new creative solutions are needed** for deploying small cells to **meet coverage and capacity needs** and to accommodate IoT.

It's the right time to seriously consider new RAN solutions that push the envelope of expectations.

Casa Systems' Radio Access Network Solutions

Casa Systems provides a range of Radio Access Network (RAN) solutions to help service providers meet coverage and capacity demands today.

With a limited amount of spectrum and few new macrocell sites available, small cells are one of the few tools service providers have to meet capacity and coverage requirements.

Casa's Small Cell Solution

Casa's small cell solution portfolio is comprised of the elements shown in Figure 1:

- The Apex™ family of small cells provides coverage and capacity solutions that service providers need

- this includes Lifestyle, Enterprise, Micro, and Strand small cells. Apex small cells operate in LTE-FDD and LTE TDD licensed bands and in the 3.5GHz CBRS band.

- The Axyom™ Element Management System (AEMS) makes small cell deployment and management more efficient. It includes H(e)MS, Hybrid SON, and other key management tools that facilitate integration with existing networks and increase RAN utilization.
- Casa's Small Cell Core includes HeNB/HNB gateways, SeGWs, ALF and the VMC. These Virtual Network Functions (VNFs) can be deployed on bare metal, as virtual machines or in containers.

All the things you'd expect from a small cell solution:

- End-to-end architecture including small cells, SeGW, HNB / HeNB-GW, HMS / HeMS and D-SON
- LTE support including licensed bands and 3.5GHz CBRS
- Carrier-grade, high reliability
- Zero touch plug-and-play deployment
- Integrated backhaul
- 2x2 MIMO

And a few that may surprise you:

- The Apex Strand - A strand mount small cell with integrated DOCSIS 3.0, 3.1 or PON backhaul
- A high density, virtualized small cell core that leverages Axyom Software Platform innovations to outperform alternatives
- X2 Gateway, S1 / X2 proxy functions
- SysLog Server and Performance Monitoring Server with support for 100+ KPIs
- Multidimensional scaling - horizontal and vertical

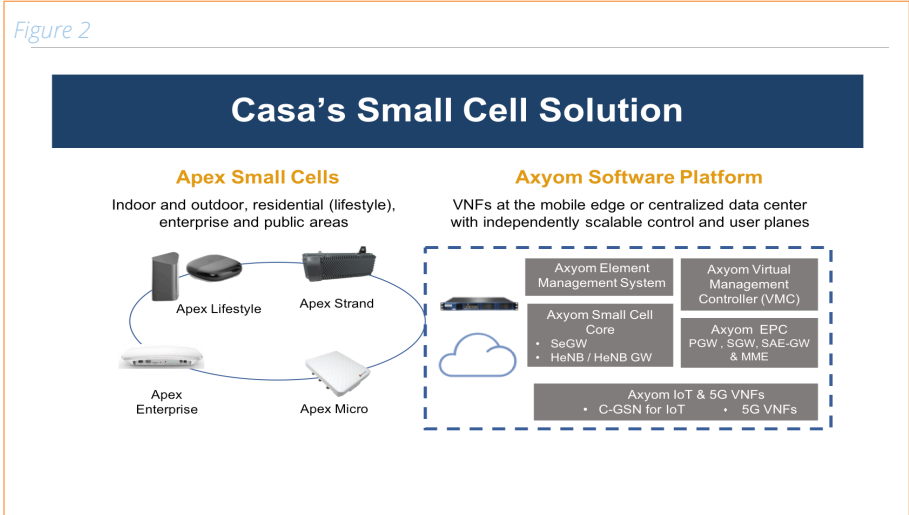
Figure 1

Casa's Small Cell Solutions

Apex Small Cells	Axyom Element Management System	Axyom Small Cell Core
<ul style="list-style-type: none"> • Multiple licensed LTE - LTE-TDD, LTE-FDD bands as well as 3.5G CBRS • Apex Lifestyle Small Cells for residential coverage • Apex Enterprise Small Cell • Apex Micro Small Cell outdoor pole and wall mount • Apex Strand - Strand mount picocell 	<ul style="list-style-type: none"> • HMS / HeMS - Home eNodeB (4G LTE) Management System and Home NodeB (3G) Management System • Real-time Hybrid SON • TR-069 Auto Configuration Server • Syslog Server • KPI Performance Management 	<ul style="list-style-type: none"> • Home eNodeB and Home NodeB (HeNB and HNB) Gateways • Security Gateway (stand-alone or integrated) • Axyom Location Function (ALF) • Virtual Management Controller (VMC) provides VNF management and integration

The HeNB/HNB gateway not only aggregates thousands of small cells, but also shields the core and provides X2 gateway and X1/S2 proxy functions. Casa's Security Gateway can be deployed as a stand alone security service or in conjunction with the small cell gateways, applying powerful security measures without impeding throughput. The Axyom Location Function is critical in some countries since it helps to support emergency services (E911, 112). Finally, the Virtual Management Controller (VMC) provides VNF management and integration.

Figure 2



Apex Small Cell Portfolio

Casa's Apex family of small cells includes Lifestyle, Enterprise, Micro and Strand small cells. The portfolio addresses the key coverage and capacity challenges faced by any service provider.

Apex Lifestyle Small Cells

Apex Lifestyle Small Cells are the perfect design mix of form meeting function. Casa believes that a small cell should integrate with a consumer's personal environment and become part of the home or office décor instead of being banished to a closet or basement. Casa's Lifestyle Small Cell form factors include the Triangle and the Pebble. These stylish designs are meant to be placed on a counter, shelf or desk. Color, shape, texture and accessory options will help service providers mitigate customer

churn and even add revenues through accessory sales.

The attractive designs not only mean better acceptance by subscribers, but also better RF coverage. Utilitarian-looking small cells will be hidden away and as a result, they will have to fight against more RF propagation barriers – walls, ceilings and cabinet doors. However, from its prominent position in the home or office, the Lifestyle small cells will maximize coverage and throughputs. Overall, subscribers will receive a better experience with a Lifestyle small cell.

Apex Enterprise Small Cell

Designed to deliver coverage and capacity to enterprises, the Enterprise 4G small cell supports 2 LTE carriers and up to 16 scheduled / 64 connected users per TTL. The Enterprise small cell can be quickly deployed in existing LTE network and can

connect via a HeNB gateway or directly to the EPC. Delivering 400 Mbps DL / 75 Mbps UL, with a small form factor, the Enterprise small cell is ideally suited for the densification and performance requirements of next generation enterprise services.

Apex Micro Small Cell

The Apex iMicro Small Cell are designed for environments where there are a large number of subscribers and a larger coverage area is needed. Deployment examples include, enterprises, public venues like campuses, malls and airports. The Apex Micro can be wall or pole mounted and supports licensed LTE bands as well as 3.5 GHz CBRS.

Apex Strand Small Cell

The Apex Strand Small Cell takes advantage of existing HFC cable strand to

Figure 3



cost-effectively support two LTE carriers (licensed LTE Bands or CBRS).

Both MSOs and Mobile Service Providers can take advantage of the Apex Strand. The solution helps solve the powering, backhaul and site issues that have plagued large scale, small cell deployments for many years. By using the cable strand, small cell backhaul can be supported with DOCSIS 3.0, 3.1 or PON and the power can be tapped from the HFC plant. To develop the Apex Strand, Casa leveraged its experience developing, testing and deploying strand mounted Distributed Access Architecture (DAA) nodes for MSOs. Casa is a leader in the cable broadband market and as a result, Casa's DOCSIS knowledge and its experience with cable strand Outside Plant Equipment deployments provide a significant technology advantage.

Axyom Software Platform

Casa Systems has fundamentally rethought the way mobile, cable and fixed services are delivered. We saw that Network Functions Virtualization (NFV) was moving in the right direction, but also saw the need for optimization. For many vendors, network functions are virtualized, but they are just mirrors of their former physical selves. In the industry, this is known as the "lift and shift" model of virtualization. Casa realized that there is a better approach. Casa develops its Axyom VNFs from the ground up to ensure that Casa's VNFs are optimized for a virtual compute environment and Axyom VNFs can scale both horizontally and vertically. The result is that Casa's Axyom Software Platform eliminates the poor performance found with many of today's VNFs.

Deployable as virtual machines, in containers or on bare metal, in a centralized cloud or at the network edge, Casa provides service providers with flexibility and subscribers with low latency.

Supporting Casa's own small cells or third party RAN solutions, the Axyom Software Platform is designed to deliver ultra-broadband services. The Axyom software platform provides security, aggregation and management of micro-services that are optimized and can be used across mobile and fixed networks.

The functions and capabilities delivered by Axyom for Casa's small cell solution include the Axyom Element Management System, SeGW, HeNB-GW, HNB-GW and ALF functions. The Axyom Virtual Management Controller (VMC) provides the Casa small cell solution with VNF management, simplifies northbound integration with orchestrators, and provides FCAPS capabilities for integration with OSS / BSS systems.

Axyom HeNB & HNB Gateway

The Axyom Software Platform is designed to simplify the small cell network. Casa's Axyom HeNB (Home eNode B) Gateway and HNB (Home Node B) Gateway and Small Cell Manager functions are compatible with third-party small cells. This enables a service provider to simplify their network with a single supplier for small cell gateways and management.

Our HeNB and HNB Gateways provide X2 gateway and S1 / X2 proxy functions, enabling abstraction of the small cells as a single logical interface, simplifying

integration with macro networks.

Specifically, we support for IPv6 S1 traffic connectivity to an IPv4 EPC core and also support for 28 bit to 20 bit eNB ID mapping for integration with legacy MMEs. All management and control are from a single pane of glass via an intuitive graphical user interface (GUI). Hybrid SON enables autoconfiguration, self-optimization and self-healing.

HeNB & HNB Gateway

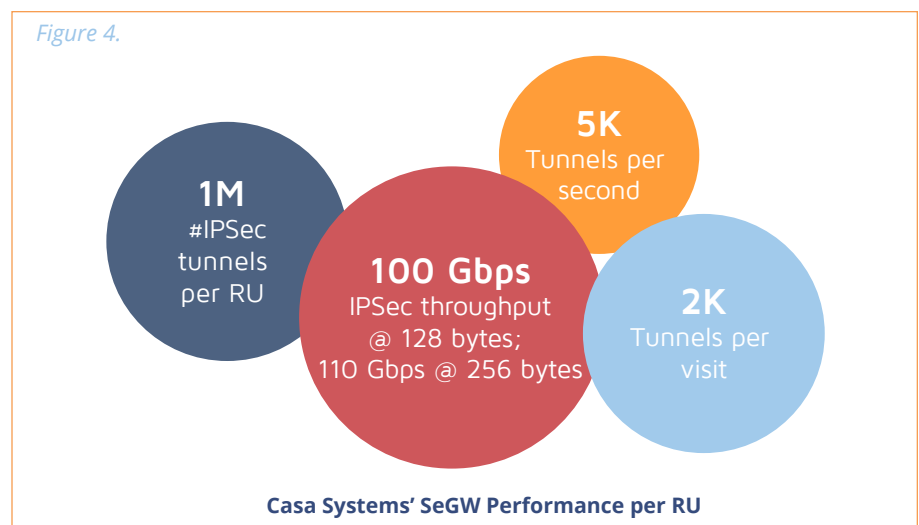
Casa's HeNB and HNB Gateways solutions enable simple, seamless, highly secure access to subscribers, and function as X2 gateways and S1 / X2 proxy functions for simplified HetNet integration.

Supporting hundreds of thousands of HNBs and HeNBs and millions of UEs per chassis, Casa has raised the bar for performance and scalability. Working in conjunction with Casa's SeGW, the HeNB and HNB Gateways deliver tightly integrated and flexible solutions to meet the evolving demands of today's mobile service providers.

SeGW

As an increasingly varied assortment of connected devices attach to mobile networks over an increasingly varied assortment of access types, securing both the data and the network is paramount.

Figure 4.



Solution Highlights

SeGW

- Full integration with Casa's HeNB and HNB gateways
- Extremely dense: 1M tunnels per RU
- Industry-leading throughput for small packet sizes (like those associated with IoT and voice)
- 40Gbps bidirectional encrypted forwarding performance on a 1RU server; 100Gbps on a 2RU server
- High availability / inter-chassis redundancy
- 3GPP systems aspect / security
 - 3GPP TS 33.320, 3GPP TS 33.310, 3GPP TS 33.210 and 3GPP TS 33.402
- Scalable IKEv2 and IPSec SA rekeying
- Firewall and filtering
- DDOS protection
- IPSec tunnels / MOBKE security association

HeNB / HNB GW

- Full integration with Casa's SeGW and interoperability with third-party security gateways
- 3GPP release 12 compliant including S1-MME, S1-U and X2 interfaces
- S1-Flex high availability load balancing with MME control plane resource pools
- Full idle and active mode mobility between macro and small cells and from small cell to small cell
- Open, closed and hybrid access modes
- Supports closed subscriber groups for enterprise applications

hierarchical and geographical deployments

- Auto Physical Cell-ID Configuration
- Fault and performance management for collecting fault management and SON parameters
- Status monitoring and reporting
- Small cell KPI collection and graphical presentation

Hybrid SON

Casa's Hybrid SON enables mass deployment of small cells at lower OPEX. Interaction between SON agents and SON manager assures the self-configuring, self-optimizing and self-healing actions required by complex heterogeneous networks are applied in real-time and consistently. D-SON supports plug and play self-configuration, automatic neighbor relations between small cells, and self-optimization techniques like mobility robustness optimization, mobility load balancing and enhanced inter-cell interference coordination.

Casa's SeGW enables secure access for small cells connected to the core network without sacrificing performance. The SeGW is capable of supporting millions of IPSec tunnels on a 1RU server.

Engineered to push the boundaries of what's possible, Casa's SeGW delivers best-in-class number of tunnels per RU, tunnel set up rates, IPSec throughput and performance per watt.

Re-architecting the core functions on Axyom yielded dramatic performance improvements, as illustrated in Figure 4. Casa's SeGW applies strong security without reducing performance.

Axyom Element Management System

Casa's Axyom Element Management System includes H(e)MS management

system for small cells, real-time hybrid SON, TR-069 Auto Configuration Server (with TR-196v2 and TR-181 data models), SysLog Server, and KPI Performance Management (100+ KPIs supported). All management tools are accessed via an intuitive GUI interface, providing a single pane of glass for management and monitoring.

Highlights of the Axyom Element Management System include:

- Integrated Auto Configuration Server (ACS) for the management of the H(e)NB devices using TR-069 protocol with TR-196v2 and TR-181 data models
- Full Access to all the Small Cell base station parameters
- Flexible provisioning process, supporting custom profiles,

Self-Configuration Features

A robust set of self-configuration features is provided to smooth the introduction of new small cells, enabling zero-touch deployment.

Self-Optimization Features

Features to optimize coverage, capacity and interference are critical to assure not only full utilization of network assets, but also smooth handoff, particularly for voice calls.

Self-Healing Features

Self-recovery of software is enabled through a repository of software updates, and automatic cell outage detection is enabled for small cells.

Improves Existing and Creates New End-User Experiences

Casa's small cell solutions were built with key revenue generating applications in mind, including those that are already commonplace, as well as emerging opportunities. The goal of most small cell deployments is aspiring to fix indoor coverage holes or remedy capacity deficits inside enterprises. Casa's end-to-end small cell solution is right sized for those applications.

Already have small cells deployed, but looking for a simple way to improve the quality of the user experience attaching to those cells? Axyom is designed to integrate with third-party equipment and boost the performance of those base stations.

Ready to get serious about monetizing small cell investments? Casa's access solutions are designed to deliver presence and location information, traffic offload, PBX features, IMS features and more. In a retail mall business case example, zonal presence and traffic insights via Casa's Apex small cell and Axyom Software Platform yielded a payback period of < 1 year and an ROI over 40%.

Casa's Small Cell solutions facilitate better experiences, new experiences and monetization today.