

Small Cell Solutions

SOLUTION BRIEF

For many years, the mobile industry has been in handwringing mode over rising mobile broadband demand and declining ARPUs. 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 the industry starts to get a clearer vision of 5G, the impetus for deploying small cells expands beyond coverage and capacity to the need to accommodate IoT and the opportunities for monetizing small cell deployments through a variety of tailored offerings to enterprises.

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

Casa Systems' Mobile Access Solutions

Casa Systems provides a range of mobile access solutions to help service providers meet demands today and prepare their networks for 5G. Casa's end-to-end mobile access solutions support 3G and 4G cellular as well as Wi-Fi, LTE-A, 3.5GHz CBRS and Multefire access. A range of indoor and outdoor small cells provide not only the coverage and capacity service providers need, but also location and presence insights which can be used toward monetization. Small cell deployment and management is made simpler and more efficient with Casa's Axyom Small Cell Manager, which includes H(e)MS, Hybrid SON, and other key management tools that facilitate integration with existing networks and increase RAN utilization.

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
- Multi-standard small cells (3G / 4G)
- Carrier-grade, high reliability
- Zero touch plug-and-play deployment
- Integrated backhaul
- 2x2 MIMO
- LTE-A, 3.5GHz, CBRS and MultFire™ support

And a few that may surprise you.

- High density gateways deployable at the edge or in a centralized data center outperform legacy alternatives
- X2 Gateway, S1 / X2 proxy functions
- SysLog Server and Performance Monitoring Server with support for 100+ KPIs
- Multidimensional optimization and application enablement

Casa Mobile Access Solutions

Apex Small Cells	Axyom Small Cell Manager	Axyom Access Gateways
<ul style="list-style-type: none"> • Multi-standard (3/4G, 4G, LTE-A, 3.5GHz CBRS, MulteFire) Indoor • 4G Indoor Enterprise • 4G Indoor Residential • 3G / 4G Outdoor Picocell 	<ul style="list-style-type: none"> • HMS / HeMS • Real-time Hybrid SON • TR-069 Auto Configuration Server • Syslog Server • KPI Performance Management 	<ul style="list-style-type: none"> • HNB / HeNB Gateway • Security Gateway (stand-alone or integrated with small cell gateways) • Evolved Packet Data Gateway (ePDG)

5G Ready E2E Portfolio

High capacity HNB / HeNB gateways can be instantiated on a 1RU or 2RU COTS platform at the metro edge, or deployed in a centralized cloud. These gateways not only aggregate hundreds of small cells, but also shield the core and provide 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. And, Casa's ePDG provides Wi-Fi access support, an increasingly important component of mobile service provider's access networks.

End-to-End Small Cell Architecture

Casa's mobile access portfolio is comprised of the elements shown in Figure 1 including:

- Range of small cell options, including multi-standard or single standard, indoor or outdoor, residential or enterprise
- Virtualized SeGW, HNB-GW, HeNB-GW and ePDG+PGW functions
- X2 Gateway, S1 / X2 proxy functions
- HMS / HeMS management system
- Hybrid SON
- KPI management (over 100 KPIs).

The Axyom ultra-broadband software framework also includes core VNFs (S-GW, P-GW and SAE-GW) and interworks seamlessly for expanded applications, including VoWi-Fi and VoLTE.

Designed to Simplify Network Complexity

All the RAN and core functions service providers need to enable ultra-broadband services are in the Axyom Ultra-Broadband Software Framework. Our small cell 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.

All management and control is from a single pane of glass via an intuitive graphical user interface (GUI). Hybrid SON enables autoconfiguration, self-optimization and self-healing.

Casa's Axyom gateway functions are compatible with third-party small cells, and offer multi-standard support, tight integration with macro networks, integration of open source solutions and interoperability with third-party software.

Axyom Ultra-Broadband Edge Platform

Casa Systems has fundamentally rethought the way mobile services are delivered. We saw that virtualization of RAN and core functions at the network edge was moving

in the right direction, but also saw the need to move beyond NFV 1.0, where network functions are virtualized as mere mirrors of their former physical selves. Instead, we stepped forward to NFV 2.0, where network functions are optimized to dynamically scale in the multiple dimensions required by the applications service providers offer today and will offer in the future. Designed to simultaneously scale CPU, memory and throughput, Casa's Axyom framework eliminates the performance trade-offs present in many of today's solutions.

Deployable at the network edge in a 1RU or 2RU configuration, or in a centralized cloud as independently scalable control and data forwarding elements, we enable placement of network functions where they make the most sense for each application. This dramatically improves performance, protects the network core, enables higher QoE and readies access networks for 5G demands.

Coupled with our own, or third party, small cells and / or Wi-Fi access points, Axyom is designed to deliver ultra-broadband services from a variety of access types. The platform provides security, aggregation and management functions as well as easy integration with other open solutions and existing architectures.

The fundamental capabilities delivered by Axyom for Casa's small cell solution include the SeGW, HNB-GW and HeNB-GW functions.

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. Casa's SeGW enables highly secure access to subscribers as they roam between trusted

Figure 2

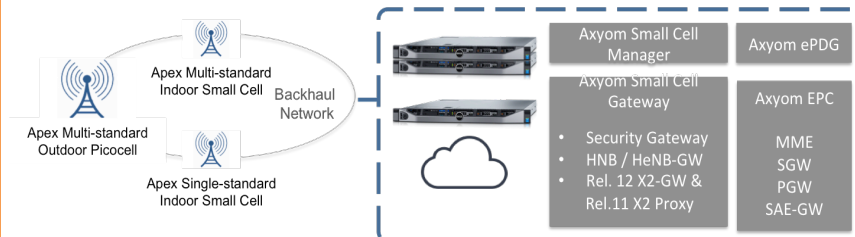
Casa Systems' End-to-end Small Cell and Mobile Edge Computing

Apex Small Cells

Indoor and outdoor, single and multi-standard with integrated backhaul

Axyom Ultra-broadband Software Framework

VNFs on 1RU or 2RU servers at the mobile edge or in centralized cloud data center environment with independently scalable control and service forwarding VNFs.



and untrusted networks, without sacrificing performance. Capable of supporting millions of IPSec tunnels on a 1RU platform, the solution also scales control plane and data plane functions independently, allowing rapid adaptation to changes in bandwidth and session requirements. Engineered to push the boundaries of what's possible, Casa's SeGW delivers best-in-class number of tunnels per RU, tunnel setup rates, IPSec throughput and performance per watt.

SeGW Highlights

- Full integration with Casa's HNB and HeNB gateways
- Extremely dense: 1M tunnels per RU
- Industry-leading throughput for small packet sizes (like those associated with video streaming 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 / MOBIKE security association

Dramatic Performance Improvements

Re-architecting the RAN and core functions on Axyom yielded dramatic performance improvements, as illustrated in Figure 3. Strong security

is applied at the edge, protecting the network, but without reducing performance. Putting the right functions close to the user and intelligent pipeline processing are two of the keys to the impressive performance improvements delivered by Casa's solutions.

HNB and HeNB Gateways

Casa's HNB-GW (Home Node B gateway) and HeNB-GW (Home eNode B gateway) solutions enable simple, seamless, highly secure access to subscribers, and function as X2 gateway 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 small cell gateways deliver tightly integrated and flexible solutions to meet the evolving demands of today's mobile service providers.

Axyom Small Cell Manager

Casa's Axyom Small Cell Manager includes H(e)MS management system for small cells, real-time hybrid SON, TR-069 Auto Configuration Server (with TR-196 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.

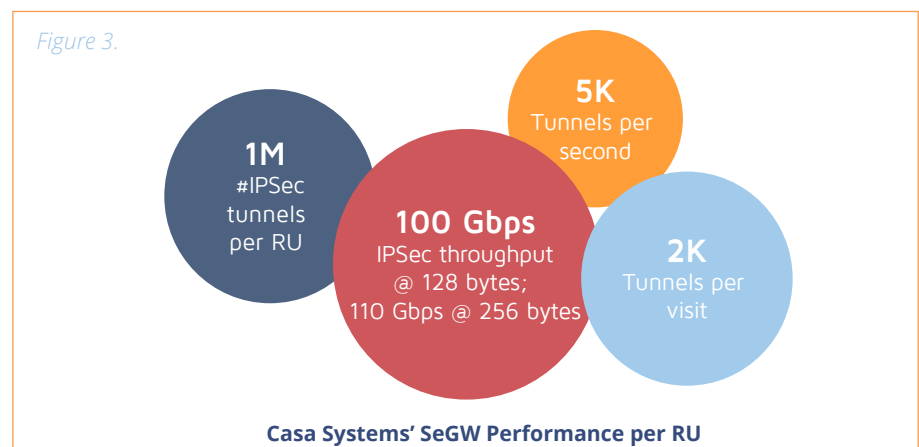
HNB / HeNB GW Highlights

- Full integration with Casa's SeGW and interoperability with third-party security gateways
- 3GPP release 9, 10, 11 and 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

Highlights of the Axyom Small Cell Manager include:

- Integrated Auto Configuration Server (ACS) for the management of the

Figure 3.



H(e)NB devices using TR-069 protocol with TR-196 and TR-181 data models

- Full Access to all the Small Cell base station parameters
- Flexible provisioning process, supporting custom profiles, 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.

Self-Configuration Features

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

- **LTE:** Automatic neighbor relations, radio environment monitoring, automatic physical cell ID assignment, frequency synchronization, dynamic S1-MME configuration and dynamic X2 configuration.
- **3G:** Automatic location area code /

routing area code assignment, automatic primary scrambling code assignment, automatic common pilot channel max power setting, radio environment monitoring, frequency synchronization, automatic UTRA absolute radio frequency channel assignment.

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.

- **LTE:** Mobility load balancing, mobility robustness / handover optimization, random access channel optimization, coverage and capacity optimization, automatic software updates and automatic and periodical Tx Power adjustment based on surrounding RF changes.

Self-Healing Features

Self-recovery of software is enabled through a repository of software updates, and automatic cell outage detection is enabled for 3G, 4G and dual-mode small cells.

Apex Small Cell Portfolio

Casa's Apex small cell solution includes our multi-standard low power small cell ideal for enterprise applications. Designed to flexibly support multiple band classes and band combinations, the Apex multi-standard small cell supports 3G/4G, LTE-A, 3.5GHz CBRS and MulteFire.

Apex Multi-Standard indoor Small Cell

Supporting 3G and 4G as well as LTE-A, 3.5Ghz CBRS, and MulteFire, this small cell is a flexible solution for efficient utilization of licensed or unlicensed spectrum. Its small size and low profile (Figure 3) make it ideal for indoor deployments to deliver coverage

and capacity as well as enabling granular network optimization and potential revenue generation from finer location insights.

Apex 4G Indoor Enterprise Small Cell

Designed to deliver coverage and capacity to enterprises, the Enterprise 4G small cell supports up to 32 users. The Enterprise 4G can be quickly deployed in existing LTE infrastructure and can connect via a small cell gateway or directly to the EPC. Delivering 150Mbps DL / 50Mbps UL, with low power requirements and a small form factor, the Enterprise 4G small cell is ideally suited for the densification and performance requirements of next generation enterprise services.

Apex 4G Indoor Residential Small Cell

Apex Residential 4G small cells offer a right sized solution for consumers, SOHO, or even for small businesses. Supporting up to 16 users, and delivering up to 150Mbps DL / 50 Mbps UL, Casa's residential small cells provide not only coverage and capacity, but also easy integration and coordination with existing LTE networks in HetNet environments.

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. Some small cell deployments are pretty basic, simply 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 yielded a payback period of < 1 year and an ROI over 40%. Casa's Mobile Access solutions facilitate 5G readiness and enable better experiences, new experiences and monetization today.

Figure 4



Apex Multi-Standard Small Cell

Built by a Company That's Built to Last

Why Casa Systems for your mobile access needs?

- Casa Systems has experience in delivering carrier-grade solutions, as proven by the number of networks in which our cable access products are deployed around the globe. We understand and deliver "carrier-grade"
- Casa Systems' mission is to simplify networks while improving performance and end-user experiences
- Casa Systems is unencumbered by any need to preserve legacy mobility products or revenue streams, enabling a fresh approach to the coverage, capacity, operational complexity and monetization issues facing mobile service providers
- We've fundamentally rethought the way to provision services at the mobile edge and at the service edge
- Our engineering prowess has produced best-in-class mobile-edge performance on a per RU basis
- Service providers need a company like Casa Systems – able to bring a fresh approach to small cell and mobile edge solutions, but with carrier experience and a mission to simplify and improve service provider networks