

SOLUTION BRIEF

Canopy[®] Wireless Broadband Platform



Issue 1
January 2007

Coverage Extender

MOTO⁴**WI**

Notices

The vendor data in this Application is derived from the Motorola Canopy® System User Guides. Motorola provides this vendor data for Canopy user information only and does not provide any recommendations.

Please refer to the Canopy System User Guide, posted at www.motorola.com/canopy for:

- Personal safety guidelines in Preventing Overexposure to RF Energy
- Important regulatory and legal notices

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New in This Issue

This document is Issue 1 of the Coverage Extender Solution Brief. This section is a placeholder where changes will be listed in future issues.

Using This Coverage Extender Solution Brief

This document should be used with the following Motorola Canopy® documentation:

- Various Motorola Canopy System User Guides

Visit the Canopy Support Web Site to download the latest Canopy software and Canopy User Guides - http://www.canopywireless.com/support_home.php

Searching This Solution Brief

To search this document, look in the Table of Contents for the topic. To find information based on any expression used in this document, open the document in an Adobe Reader® session and

- Use the page numbers at the bottom of the screen and in the thumbnails. These match the page numbers in the Table of Contents.
- Use the **Edit→Search** command (or **Ctrl+F**) to find a word or phrase.¹

Getting Additional Help

To get information or assistance as soon as possible for problems that you encounter, use the following sequence of actions:

1. Search this document, the user manuals that support the modules, and the software release notes of supported releases
 - a. in the Table of Contents for the topic.
 - b. in the Adobe Reader® search capability for keywords that apply.¹
2. Visit the Canopy systems website at <http://www.motorola.com/canopy>.
3. Ask your Canopy products supplier to help.
4. Gather information such as
 - the IP addresses and MAC addresses of any affected Canopy modules.
 - the software releases that operate on these modules.
 - data from the Event Log page of the modules.
 - the configuration of software features on these modules.
 - Run Gather Customer Support Tool within CNUT
5. Escalate the problem to Canopy systems Technical Support (or another Tier 3 technical support that has been designated for you) as follows. You may either
 - send e-mail to technical-support@canopywireless.com.
 - call 1 888 605 2552 (or +1 217 824 9742).

For warranty assistance, contact your reseller or distributor for the process.

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Abstract

Canopy solutions are part of Motorola's MOTOwi4™ portfolio of innovative wireless broadband solutions and services that create, complement and complete IP networks. Delivering IP coverage to virtually all spaces, the MOTOwi4 portfolio includes wi4 Fixed, wi4 WiMAX, wi4 Mesh, and wi4 BPL (Broadband over Powerline) solutions for private and public networks.

A Canopy-based BWA service provider generally extends coverage by deploying additional base stations. There arise circumstances in which the Canopy-based operating company wishes to extend their current coverage without low level capital investment. This is the rationale for the development of the Coverage Extender (CE).

This document describes the Coverage Extender in the context of a typical Canopy-based BWA provider.

1.0 The Need for Extended Coverage

Canopy is a six sector point-to-multipoint (PMP) base station (BS) complex providing BWA over a range of several miles depending upon frequency band and other radio considerations. By deploying a grid of Canopy BSs, a given service area may be completely covered.

Figure 1 illustrates such a Canopy BS grid and the resulting coverage area. The sector letters A, B, and C represent particular channel frequencies.

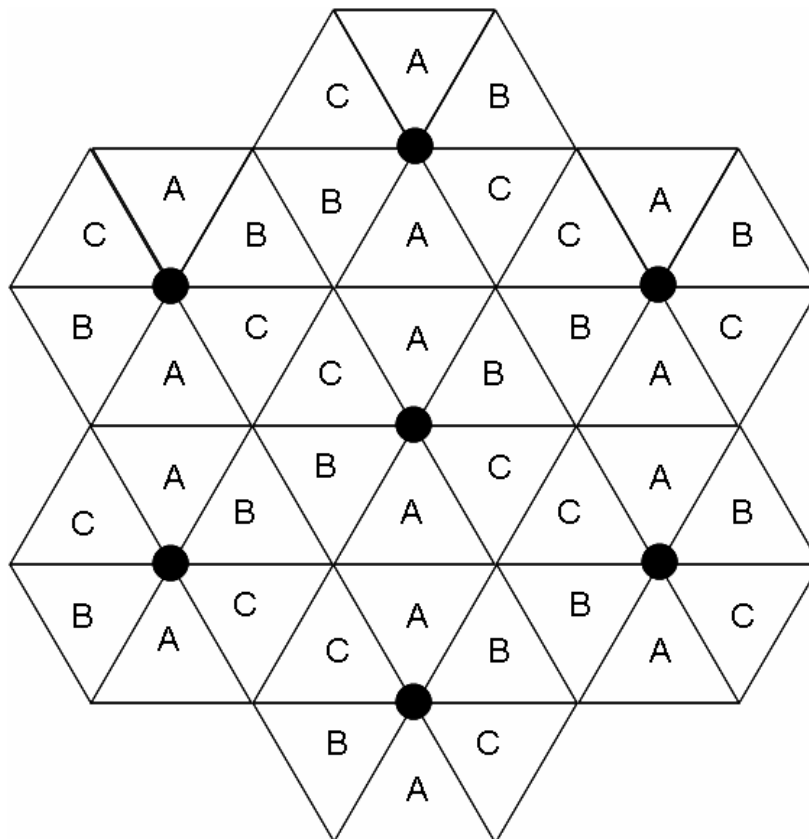


Figure 1 Usual Canopy coverage map.

It may be that, over time, the potential service area grows beyond that originally covered.

Historically, a Canopy BWA operator has had only one option, namely, construct another complete Canopy BS. This includes the BS's Cluster Management Module (CMM) and associated Access Points (AP) – six APs if constructing a fully populated BS. This new BS's customer traffic would have to be backhauled into the existing core network, via either a wired solution or a point-to-point (PTP) wireless solution.

Say, for example, the “northeast” corner of the original coverage area is undergoing development, with several new potential customers and the promise of many more customers over time. In this case, economic justification of establishing a new Canopy BS might not be possible, as the relatively few initial customers may not allow an acceptable return on investment (ROI). Now, q Canopy operator has an alternative technology to deploy in this scenario – the Coverage Extender.

The CE permits service coverage to be cost effectively extended without the need for an additional fully configured Canopy BS.

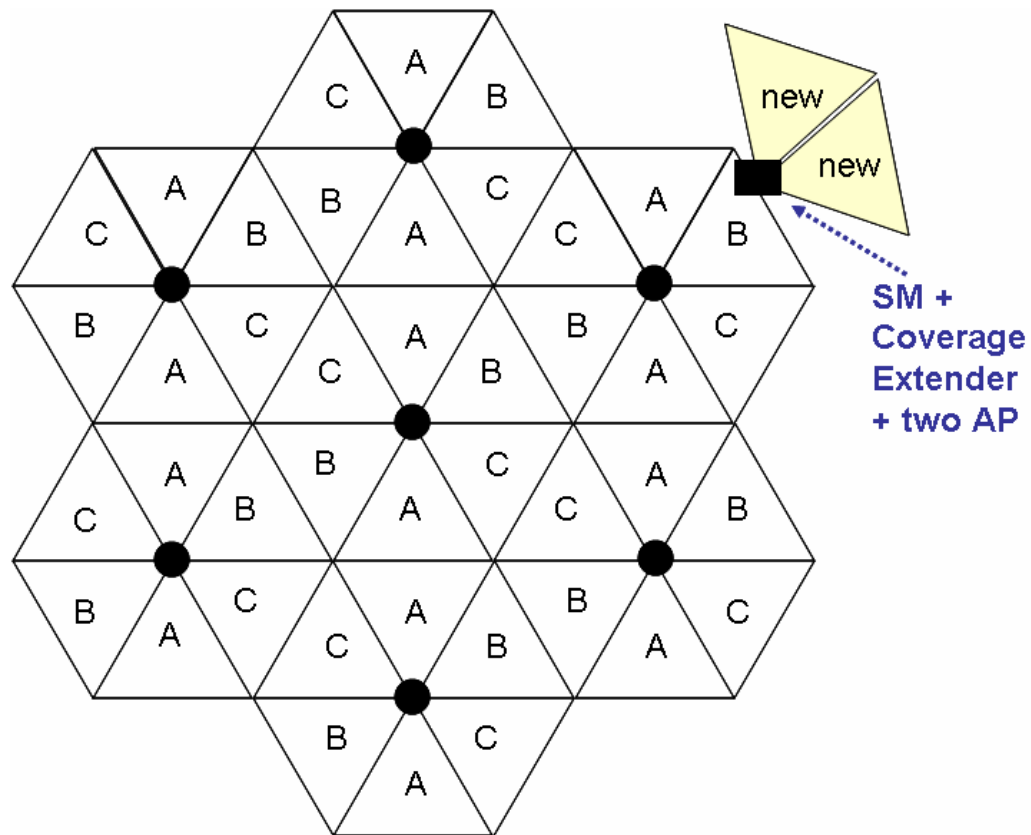


Figure 2 Coverage Extender provides two additional Canopy AP sectors.

Figure 2 illustrates circumstance in which new potential customers exist to the northeast, beyond the existing Canopy network coverage area. A Subscriber Module (SM) – new to or existing within an AP sector – is augmented by a CE and, in this particular case, two additional Canopy Access Point (AP) sectors. These two new AP service sectors are shown directed out to the northeast thereby extending BWA service coverage into the previously unserved territory.

The channel frequencies of the two new APs must be selected appropriately; they can be a completely different frequency band from that of the existing coverage. Thus, at least two “clear” channel bandwidths must be available.

Each of the new AP sectors can then be populated with the SMs of the new customers in the extended area. The new, additional customer traffic transits via the CE and is backhauled via the “original” (new or existing) SM.

The CE aggregates customer traffic from multiple SMs, then presents that aggregated traffic flow to a single SM for backhaul. The quantity of new customer traffic is limited to that available in the operator’s original AP sector network design.

1.1 Adding Indoor Coverage to Existing Infrastructure

Coverage extension can be accomplished in other ways beyond the use described above.

For example, the CE may be sited within existing Canopy coverage to provide “dual band” access in some particular local area.

Consider a case in which a geographical area is currently well covered by a 2.4 GHz Canopy solution. In general, this and other Canopy frequency bands are strictly line of sight (LOS0, that is, without the ability to penetrate building structures).

Canopy’s 900MHz product operates over a more narrow channel (8MHz versus 20MHz). This channel supports a 6 Mbps signaling rate (maximum), is NLOS, and penetrates into building interiors. As has been publicly announced, a new 900MHz Indoor SM product will become available in 2Q2007.

When an operator introduces a CE to this network scenario this unit will employ the existing coverage’s SM (say 2.4GHz) to backhaul a three sector AP900 base station site to where a potential set of indoor customers exists. These potentially new indoor customers can be added without the cost of a complete Canopy 900MHz BS .

The Coverage Extender could be used to extend coverage to any available frequency band.

1.2 Coverage Extender for Mesh Network Backhaul

Out-of-doors IEEE 802.11b/g (2.4GHz band) and 802.11a (5.8GHz band) are often used together in a network for customer access and mesh backhaul respectively. Each “mesh island” can be connected to a wired infrastructure or wirelessly backhauled. Canopy, in another frequency band (5GHz band), is excellent and proven for the wireless backhaul application. Note, 5.4GHz, having many non-overlapping 20MHz channels (the band is 255MHz wide), is exceptionally well suited for the WiFi mesh island wireless backhaul.

Sometimes the “mesh backhaul” is deployed in the same frequency band (say 2.4GHz) as the customer access network layer. Although this application avoids a “dual radio” requirement the “mesh backhaul” will consume customer promised bandwidth which limits the capacity for customer access.

The CE is a practical and cost effective network addition as a WiFi backhaul (at either the primary or secondary level) to an existing Canopy complex.

The CE could be colocated with a Motorola point-to-point wireless link for backhaul to a central aggregation point. Each of the three CE APs could be wirelessly connected to remote SMs colocated with the WiFi mesh island aggregation AP. In this situation, each WiFi mesh island is wirelessly backhauled, point-to-multipoint via a CE complex, with that being wirelessly backhauled point-to-point.

In some extreme cases, the CE complex may also be backhauled by way of a SM via the already existing point-to-multipoint based Canopy coverage. In most common cases this will not be necessary and the WiFi mesh island will have enough aggregated customer throughput requirement that a SM-based Canopy PMP backhaul is insufficient.

In the next section, the particulars of the CE are described.

2.0 Coverage Extender Deployment

In this section, the components necessary to deploy the CE are described and illustrated.

As implied above the CE scenario consists of a new or existing SM, a new CE and either one, two, or three new AP, and a set of new SMs servicing the new extended coverage area. The CE's SM (for backhaul) is located in an existing AP sector so must necessarily be of that particular channel frequency. The CE's up to three APs must be operating in another frequency band (from the SM), and thus are, in general, in a different frequency band. Thus, at least two "clear" channel bandwidths must be available.

Actually the CE's SM and its three APs can successfully operate with a 40MHz channel separation (between channel centers). Note this means one "empty channel" between the out-of-phase channels.

This requirement results from the CE's SM being in the "receive mode" when the CE's APs are in the "transmit mode". Since the CE's APs are "shouting in the ear" of the CE's SM, there must be a sufficient difference in the respective channel frequencies for reliable operation.

Each AP provides coverage over its approximately 60° sector, so two APs cover 120°, and three APs coverage 180° or "half a circle". Because the CE is intended to increase Canopy coverage at the edge of existing coverage, the "half a circle" capability is necessarily sufficient. Consequently, the CE is limited to three APs.

As stated in the previous section, another reason to restrict the CE to a maximum of three new AP sectors is that the accumulated customer traffic is, in general, aggregated and "backhauled" via one SM which is competing for Canopy radio bandwidth in the original "backhaul sector". Thus, the CE must be deployed in such an environment that the customer generated load in the new CE sectors is relatively light, as is expected and likely in new fringe coverage areas.

2.1 A Subscriber Module

A CE is sited immediately adjacent to a new or existing SM, that is within 10m. By definition, the SM must be configured with the same channel frequency as every other SM in its particular BS sector.

The purpose of this SM is to backhaul the aggregated traffic generated to and from the new, additional AP sectors.

Recall that a SM derives synchronization from its associated AP, and is locally powered via a proprietary power over Ethernet (only about 7W). Note that the SM is powered by the CE in this context via the same proprietary power over Ethernet.

Since the SM already has synchronization (from its AP) it can be the synchronization source for the CE. The SM provides synchronization to the CE via its RJ11 port. As mentioned above, this sync signal is used to time the CE's APs, and so the CE's AP will be on the same Tx/Rx phase as all other Canopy APs, but the CE's SM will be "out of phase" Rx/Tx cycle.

Note that the SM will have both an RJ45 Ethernet cable and a RJ11 cable connecting it to the CE.

2.2 A Coverage Extender Module

The prime component is the CE module itself, as shown in Figure 3. Note the CE module has the same general form factor properties as other Canopy modules - only wider.

The major distinction of a CE, compared to Canopy SMs and APs, is that it is not a radio. The CE is a hardened five-port Ethernet switch having Canopy's proprietary "power over Ethernet" and "sync pulse" capability. Because the CE doesn't have a radio, it may be oriented in any convenient direction.

The CE module has power input via an associated "power brick" deriving power from the utility grid. Note that the CE module inputs 56VDC because it additionally powers its associated SM and APs via PoE at 24VDC. A maximum of 45W is consumed.

Figure 4 shows the relevant dimensions and weights.

The CE is a hardened five-port Ethernet switch, without any radio. In addition, the CE provides power and sync to its associated APs. Figure 5 illustrates the various CE ports.

There are five RJ45 Ethernet/sync/PoE ports and one RJ11 sync port. The associated SM uses the two left-most ports, namely the RJ11 and RJ45 cables between the SM and the CE as described in the previous subsection.

Like the Canopy infrastructure, the CE is powered via an Ethernet cable. The power (voltage and current) is higher; this "power port" is the right-most RJ45 port. Therefore, like an SM, the CE may have a "local subscriber", that is, one equivalent to being linked to the local SM. Alternatively this "subscriber port" may instead connect to a Motorola point-to-point wireless backhaul link. This will be described subsequently. If the CE is used in this way it equals that of a Canopy "half BS" cluster but without the CMM, with sync derived from a remote Canopy BS.

However, the most likely scenario is that the CE is located at an existing service subscriber site. The customer's former SM becomes the "wireless backhaul via PMP" device, and the customer moved to the CE's Ethernet/PoE port. Of course now up to three APs are sited locally as well, oriented to the directions of the needed extra coverage.

This leaves the three AP ports, labeled AP1, AP2, and AP3. By construction, these three RJ45 ports are always powered and always have sync, as the APs need these as well as the Ethernet signal. Consequently, care must be exercised not to connect the AP1, AP2, or AP3 to a local computer device as the latter may be damaged by the power and sync additions to the Ethernet signal.

Note these three new APs can be in any Canopy frequency band, not necessarily the frequency band used by the SM-based wireless backhaul.



Figure 3 Side and front views of Coverage Extender.

Maximum cable length between

- CE and SM: 10 feet (3m)
- CE and each AP: 330 feet (100m)

Electrical Power Brick

Input supply: 120-240 VAC, 50/60Hz

Output Max: 0.8 A @ 56VDC

- Outdoor rated enclosure for mounting on:

- Tower locations
- Street lights
- Buildings
- Water towers

Physical

- Height: 13" (33 cm)
- Width: 7.5" (19.0 cm)
- Depth: 3.5" (8.9 cm)
- Depth including mast mount: 5.6" (14.2 cm)
- Weight: 2.5 lbs
- -40C to +55C temperature range
- 100% noncondensing humidity
- Passive cooling
- Material: UV resistant ABS plastic

Figure 4 Properties of the Coverage Extender

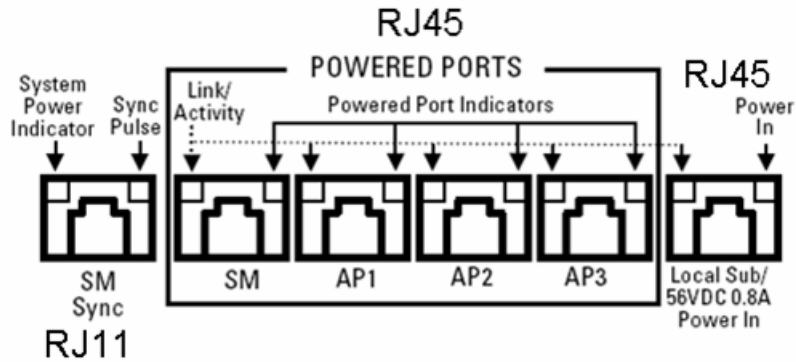


Figure 5 Schematic of the Coverage Extender’s ports.

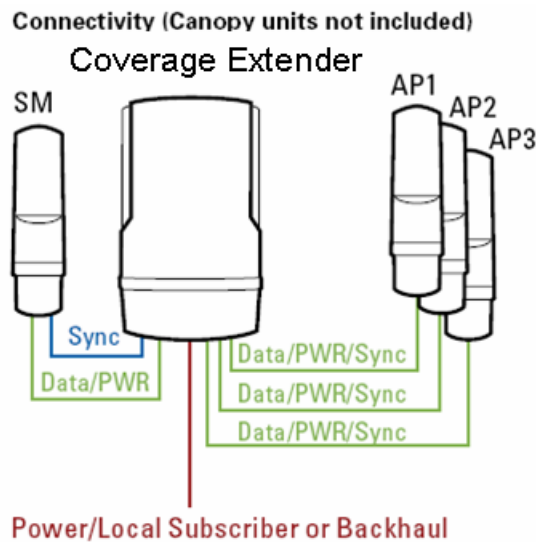


Figure 6 Relationships among a Coverage Extender and its SM and APs.

Figure 6 shows the overall layout of a CE and its associated SM and APs and local power/Ethernet cable. If the site was a pre-existing SM site, that SM’s customer feed would now be via the CE’s Local Subscriber/power port (shown in red).

2.3 Additional Access Points and Subscriber Modules

The purpose of the CE is to extend the service coverage area at minimal capital cost assuming a relatively light additional traffic load.

To that end, the three “middle” RJ45 Ethernet ports on the CE are intended explicitly for one, two, or three APs respectively. That is these three “AP ports” provide the usual proprietary power over Ethernet and sync, as well as the Ethernet signal.

These additional APs and their associated SMs are “transparent” to the CE; the traffic is switched through into the larger encompassing Canopy-based network.

2.4 Coverage Extender SM/AP Colocation Issues

As the CE functions like a Canopy base station, its APs will be transmitting in sync with other Canopy APs. Thus, the CE’s SM is receiving when its APs are transmitting, i.e. out of sync.

This out of sync operation is a challenge to proper CE operation. For successful operation, this means the CE's SM and its APs must be sufficiently separated in channel frequency.

Out of sync colocated Canopy elements must have a recommended channel center spacing of at least 40MHz but possibility more, and additional vertical separation and electromagnetic shielding may be necessary for reliable operation. Only onsite testing will definitively determine the necessary configuration. Note that building infrastructure can be exploited for shielding purposes in some instances.

2.5 Element Management of the Coverage Extender

The CE is not a radio and doesn't have an IP-based controller. This means that the CE is "un-manageable" - truly a "plug & play" device.

Consequently, Prizm, the Canopy element management system, has no access to the CE or a display icon for the CE.

From the Prizm perspective, the new AP off the CE appears in the "network tree" graphical representation, along with its subordinate SMs (up to three). This new AP and its associated new SMs are managed via Prizm exactly as all other such Canopy elements are managed.

2.6 Point to Point Backhaul of Coverage Extender

Above we assumed that the aggregated traffic from the CE was relatively light such that a SM can successfully transit that traffic to its AP.

If the traffic is relatively heavier, however, this is impractical as the backhaul AP sector is saturated with traffic.

In this case, there is still an alternative to constructing a completely new Canopy BS.

Instead, the CE complex can feed a wired, or more likely a point-to-point wireless link. In this case, the original SM can be configured to be "registered" with its associated AP but with the "customer" port disabled. In this way, the "original" SM would only provide sync to the CE complex.

The customer RJ45 on the CE (having the special 56VDC power brick) is then connected to a Motorola point-to-point wireless backhaul. This point-to-point wireless backhaul must be non-interfering with the previously installed and running Canopy system. This likely means a completely different frequency band.

In effect, this use of CE is essentially that of a standalone BS in another frequency band. The difference is the absence of a CMM and the limitation to one, two, or three APs only.

3.0 Summary and Conclusion

The Coverage Extender is an innovative solution which delivers expansion of your Canopy® network to service potential end-customers outside of your current wireless coverage range. This solution is simple and cost effective..

By taking synchronization from and utilizing for backhaul an existing or new Subscriber Module the CE is essentially able to "repeat" one, two, or three Access Point sectors via an Ethernet switch; no additional CE-based radio component is needed. The ports on this Ethernet switch are special in that they provide for Canopy's proprietary synchronization signal and power to the associated Access Points. Element management is unaffected by the presence of Coverage Extender

Additional Resources

Canopy provides two additional resources where you can raise questions and find answers:

- **Canopy User Community** <http://motorola.canopywireless.com/support/community/>
This resource facilitates communication with other users and with authorized Canopy experts. Available forums include General Discussion, Network Monitoring Tools, and Suggestions.

- **Canopy Knowledge Base**
<http://motorola.canopywireless.com/support/knowledge/>
This resource facilitates exploration and searches, provides recommendations, and describes tools. Available categories include
 - General (Answers to general questions provide an overview of the Canopy system.)
 - Product Alerts
 - Helpful Hints
 - FAQs (frequently asked questions)
 - Hardware Support
 - Software Support
 - Tools

Sending Feedback

We welcome your feedback on Canopy system documentation. This includes feedback on the structure, content, accuracy, or completeness of our documents, and any other comments you have. Please send your comments to technical-documentation@canopywireless.com.