

DEPLOYMENT EXAMPLES

TRIMAR 802.11a/b/g AP/REPEATER

Technical Manual Supplementary Information

Introduction

This document contains several examples explaining how TRIMAR APs can be deployed to deliver different types of wireless services. These examples explain only the basic considerations and should be regarded as “illustrative” rather than being complete “blueprints” for real world deployments.

A good understanding of the true capabilities of the Pegasus Wireless TRIMAR system will help network managers, administrators and technicians leverage the maximum potential from this unique and versatile product.

The examples in this guide shows how a single TRIMAR can be used to service all the wireless needs of a small office and how the system can be expanded into a larger WLAN to meet increasing demands on the wireless service.

There is an example showing how the TRIMAR can be used to build a complete ISP wireless distribution system. Finally, there is a introductory discussion on how to build a wireless mesh to provide “hotspot” Internet access to a local service area.

For questions regarding the design of your specific wireless network, please contact your wireless network integrator, your Pegasus Wireless Corporation Authorized Reseller or Pegasus Wireless Technical Support for additional assistance.

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Basic Office WiFi Intranet ABC Company Example Deployment 1

ABC Company has an open plan office that requires a simple wireless network system for servicing *all* their computing devices. The company has a single server located in the storeroom. They use a single TRIMAR AP with an 8dBI omni directional antenna. This is fixed to a convenient location on the storeroom wall.

Being a small company, they require only a basic Windows Server and a single IP subnet. They have broadband Internet access provided by a local ISP who provided them with a broadband router. Both the server and the TRIMAR AP are connected directly to this router.

ABC company has one manager, a receptionist, and about half a dozen employees. They also have visitors who come to make presentations, and oftentimes, these visitors need access to the Internet. Their desktop PCs are individually equipped with Pegasus Wireless ACR-201-Gs. These small compact 802.11g wireless bridges provide maximum data throughput and can support secure wireless WPA-PSK security. They also have superior wireless characteristics and range. Their small form factor allows the units to be mounted on the sides of individual computers.

To leverage the full potentials of their Trimar AP, they configure their TRIMAR AP as follows:

1. Since most devices that will be connecting to the TRIMAR AP will be 802.11b/g standard, they leave the TRIMAR AP's channel settings at its defaults. This allows the TRIMAR AP to intelligently select the most efficient channel for operations.
2. Four separate SSIDs are created. These are configured as follows:
 - a. **SSID#1** (name: "abc_guest"): Visible Guest account. Uses WEP security for compatibility with older 802.11b devices. (SSID#1 is chosen for this account, as some WiFi cards cannot detect "virtual" SSIDs).
 - b. **SSID#2** (name: "abc_office"): Invisible SSID account. Uses WPA-PSK with a TKIP cipher for security. This type of wireless security does not require an 802.1X authentication service. This allows the TRIMAR AP and ACR-201-Gs to authenticate amongst themselves without the need for a separate RADIUS server.

TRIMAR APs can substitute for almost all the wiring required by a traditional wired LAN.

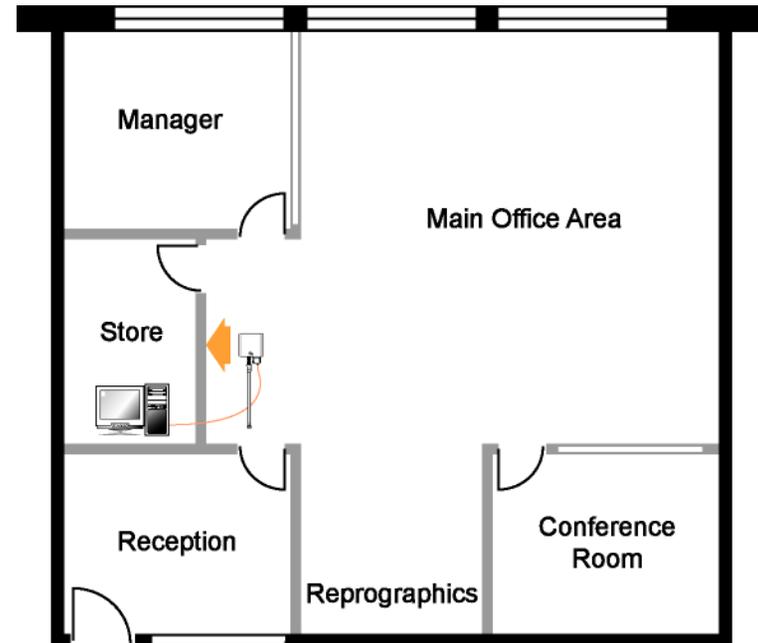


Figure 1: ABC Company office floor plan

- c. **SSID#3** (name: "abc_mobile"): Invisible SSID account for servicing mobile computing devices. Confident that all of their laptops and PDAs are able to use WPA-PSK with TKIP or AES ciphers, this SSID uses this variant of the WPA security standard. As with "b", a RADIUS server is not required.
- d. **SSID#4** (name: "abc_service"): Invisible SSID account used to service printers and other wireless devices. The company has a shared network printer in the Reprographics area that is connected to the network with an ACR-201-G. This SSID uses the same type of WPA security as "b", but a different pass phrase.

Extended Office WiFi Intranet ABC Company Example Deployment 2

Later, ABC Company is in position to expand its business and need to take on addition employees. Since there is no more room at the existing office, they need to expand into an additional premise. There are no more vacancies in their present building; however, they find a suitable location on the opposite side of the street.

To extend their network they purchase an additional three TRIMAR APs. One of these TRIMAR APs is deployed in a similar manner as in the first example for servicing the wireless network in the new building.

The other two are set up to purely connect the two networks in a classic wireless point-to-point deployment – with one exception.

APs cannot normally communicate with APs. With the advent of the Wireless Distribution System (WDS) standard, this is now possible. The two TRIMAR APs that are used to connect the two buildings will be mounted externally. These will use appropriate 5.4 GHz directional antenna to allow the TRIMAR APs to communicate using the much faster 802.11a standard.

Since the company wishes the second building to share the same Internet connection, the external TRIMAR AP at the original building is connected directly into the ISP's broadband router. No additional router is needed. To accomplish this, the two TRIMAR APs are connected back-to-back in what is referred to as a "TRIMAR Cluster". This is necessary for two reasons:

- Because, the point-to-point link requires the use of the 802.11a standard **AND** because locating wireless devices (or at least their antenna) behind glass can be problematic for a building-to-building wireless connection.
- Since most WiFi devices currently do not support 802.11a, a second TRIMAR AP is needed to service the internal wireless devices in the new office using the 802.11b/g standard.

The physical hook-up for a TRIMAR Cluster is very simple. The DC-Injectors are connected using a crossover CAT 5 cable (see Figure 4).

The externally mounted TRIMAR AP at the new building, since it has no physical connection to the network is referred to as a "Repeater"

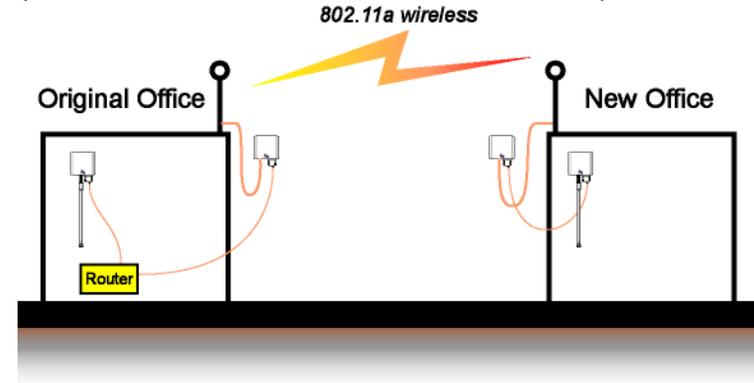


Figure 2: ABC Company wireless schematic
(See Figure 3 and Figure 4 for details)

To configure the building-to-building link, *no SSID is needed*. Both radios are set to operate in WDS mode with the WLAN MAC address of the opposite unit entered in the WDS MAC address field. For wireless security, WEP is selected using all four keys and "Open" authentication. The units are further secured using MAC address filtering and restricting the number of radios allowed to associate with it to "one" in the load-balancing section.

Although configured much like the original TRIMAR AP in the first example, the TRIMAR AP serving the internal network in the new building would use a different set of SSID names for security and wireless considerations with one exception. The SSID used for their mobile devices is the same ("abc_mobile") to allow mobile computing devices to connect seamlessly to ABC Company's wireless network whenever these are within range regardless of which building the computing device is in.

Why 802.11a is used on the building-to-building link:

ABC Company made the deliberate choice to choose the 5.4 GHz 802.11a standard for bridging this link because adding another group of computers will add more demand on the existing available wireless bandwidth. Normally, to increase the available bandwidth requires adding more radios **or** by increasing the data-throughput rate. Simply, the more economical choice, based on their requirements, is to increase their data transmission speed over this link.

Extended Office WiFi Intranet

ABC Company Example Deployment 2

(../continued)

The basic design of the TRIMAR allows the product to be deployed in different configurations to allow the product to meet the different challenges that must be met in order to deliver a reliable wireless distribution service.

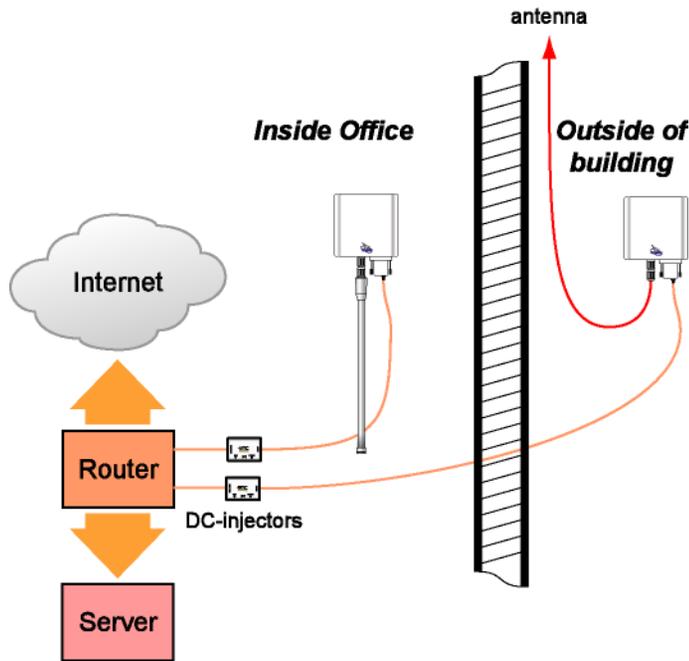


Figure 3: Wiring schematic for the original building

Figure 3 shows the basic hookup for ABC Company's original office. The hookup of the TRIMAR AP inside the office is unchanged from Example 1. The externally mounted TRIMAR AP only needs to be connected to the company's original router.

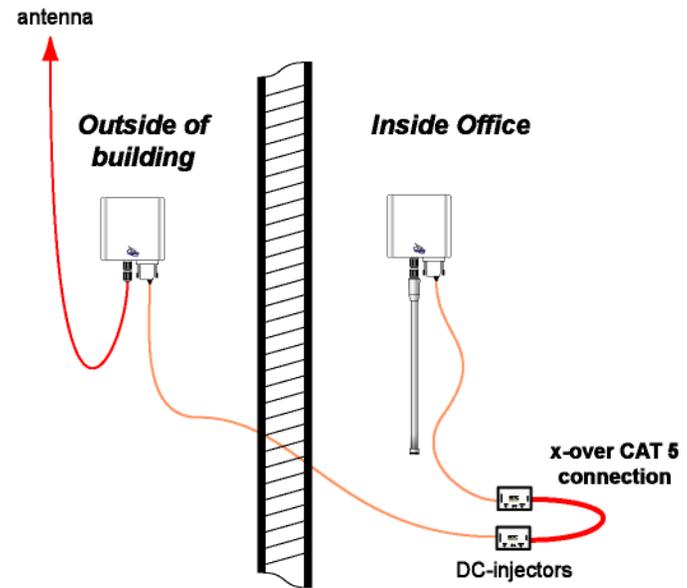


Figure 4: Wiring schematic for the new building

Figure 4 shows the hookup for the new office on the other side of the 802.11a wireless point-to-point connection. The external TRIMAR AP functions as a repeater. It is connected to the TRIMAR AP inside the new building via a crossover connection joining the two DC-injectors.

This arrangement, termed a TRIMAR Cluster, extends the functionality of the TRIMAR APs by maximizing both their 802.11a wireless capabilities as well as their 802.11b/g capabilities.

Wireless ISP

Example of a simple wireless service delivery deployment

This example shows a wireless distribution system that is commonly used by Internet Service Providers (ISPs) that provide modern communications services in rural America.

The challenges that these types of service encounter and the wireless deployment strategy used to resolve these are applicable to wireless deployments in other situations such as to service a large production plant, campus or ranch.

The major characteristic of this type of service is the need to carry data traffic over long distances for delivery to many small distribution centers; usually individual homes and small businesses. The bandwidth requirement is usually a major overall consideration. This being dictated by the number of service nodes requiring connection. Crudely, it is the aggregate sum of the total bandwidth required by each service node.

A well-designed system provides reliability of service over distance as well as adequate bandwidth capacity at the service points. TRIMAR APs make this type of deployment relatively simple with their 802.11a/b/g characteristics as well as their ability to accept different types of antenna for different applications. Using the same type of equipment throughout the system, makes installation, maintenance and servicing outages due to equipment breakdown very simple as only one type of radio is used.

Design considerations for the main trunk routes:

From the Network hub, wireless radios using directional antenna suitable for the distances to be carried are deployed. (Each antenna is orientated in the direction of the next radio in the chain). As antennas do not have infinite range, and wireless cannot pass through large obstacles such as hills, in most situations, there will be a series of relay towers between the Network hub and the service nodes. Using TRIMAR APs, the trunks would sensibly be configured to use the 802.11a standard in order to provide the maximum bandwidth possible. TRIMAR Clusters will be required at the relays and branch root towers.

Design considerations for the branches:

The Branch Service Distribution Nodes will also require a TRIMAR Cluster. One TRIMAR AP to carry the 802.11a traffic from the main trunk,

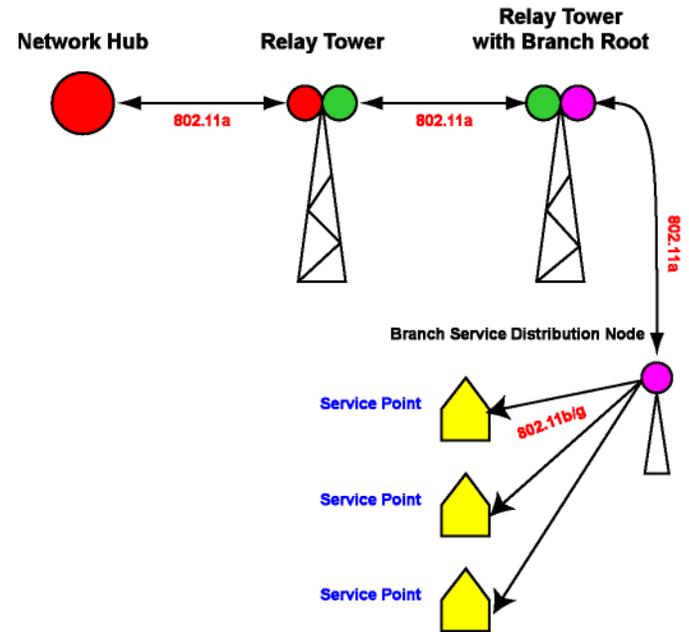


Figure 5: Simple wireless ISP deployment schematic

and another TRIMAR AP in 802.11b/g mode with an omni-directional antenna to service up to 48 Service Points. Figure 5 shows the Service Distribution Node in its simplest possible form.

802.11b/g is chosen for the last leg of the distribution chain simply to allow different types of wireless adapters to connect with the service.

Configuration considerations:

This deployment is very simple to configure:

The trunk route radios do not require SSIDs. They need to be in WDS mode with WEP encryption enabled.

Only the radio used for Service Point distribution needs an SSID. Once again, WEP will be used as many WiFi adapters cannot support WPA.

Wireless ISP

Example of a simple wireless service delivery deployment

(../continued)

Advance TRIMAR Cluster:

The TRIMAR Cluster used at the Relay tower with the Branch Root shows only one Branch Service Distribution Node. The cluster arrangement can be modified to carry wireless traffic over multiple links (in different directions). Figure 5 explains how this can be done. In practice, it will be necessary to calculate the actual bandwidth requirements before pumping the cumulative data load down the trunk root.

Figure 5 only shows the network cabling; power and antenna cables are not shown. Multiple TRIMAR APs can be connected in this manner.

If used at a remote antenna tower remember that the network switch, the DC-injectors and power outlet need to be protected from the elements!

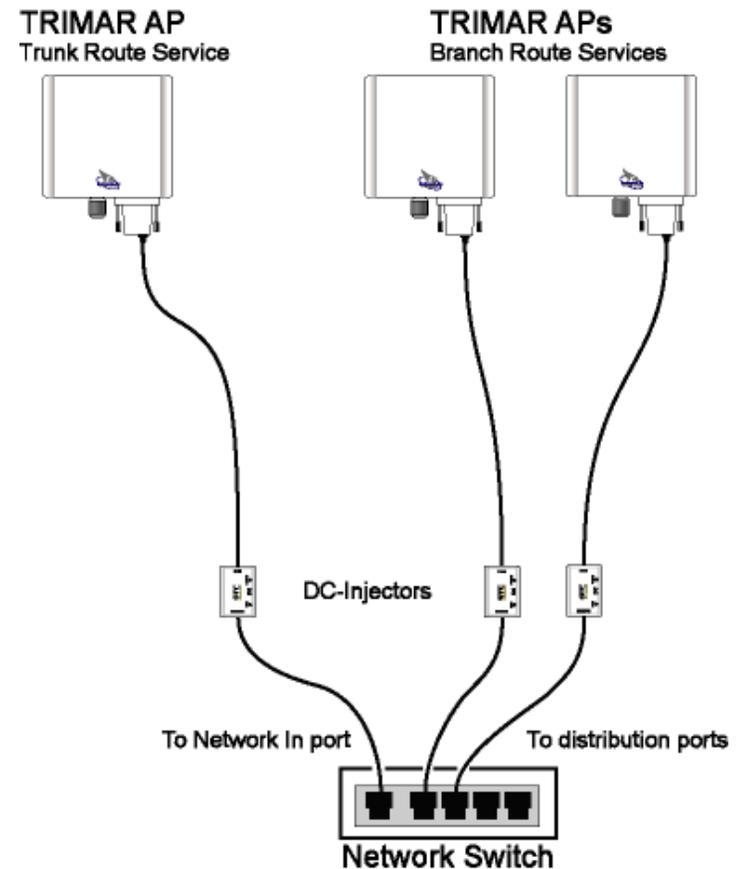


Figure 6: Advance cluster wiring (only network cabling shown)

Wireless Mesh Basics

Example showing how to build a basic wireless mesh for "hotspot" applications

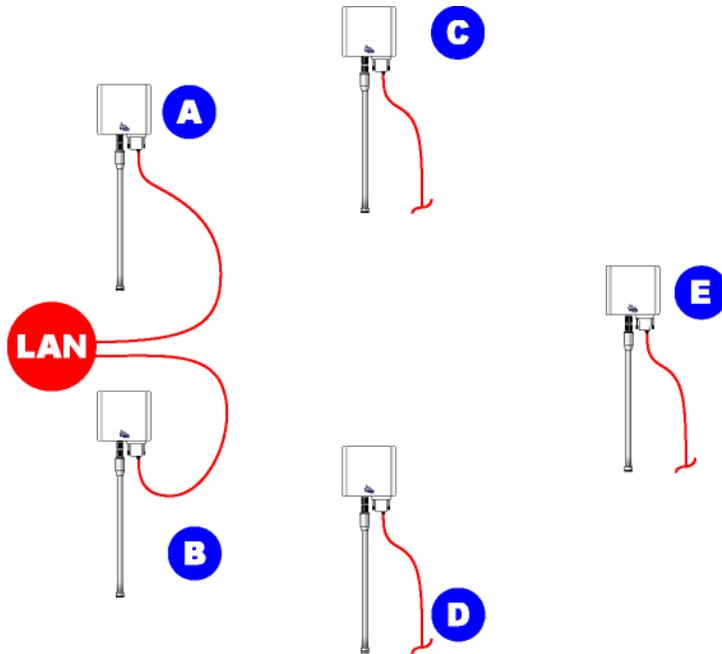


Figure 7: Wireless Mesh using 5 TRIMAR APs

This example TRIMAR wireless mesh uses 5 TRIMAR AP units. Two of the TRIMAR APs ("A" and "B") are directly connected to the LAN, the other 3 ("C", "D" and "E") functions purely as repeaters (they have no physical connection to the backbone LAN).

Configuration considerations:

- All radios have WDS and optionally WEP enabled (recommended). Each radio is allowed to communicate with all the other radios in the same mesh.
- Radios "A" and "B" **must have STP enabled**. This is to prevent network "looping", which can happen anytime a device has more than one route to the LAN backbone.

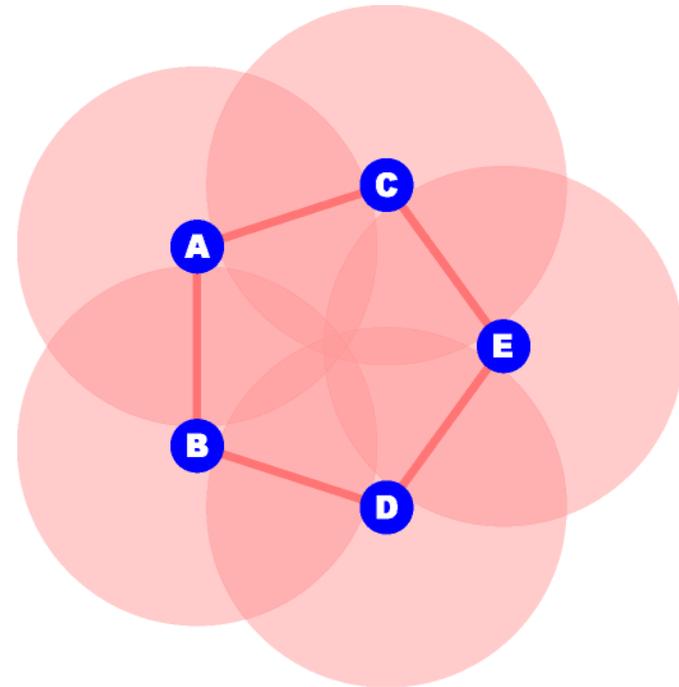


Figure 8: Wireless mesh antenna coverage and overlap

Antenna Deployment Strategy:

Examining the antenna coverage areas reveals how the meshing works. It should be pointed out that most meshes are constructed using omnidirectional antennas. Note the areas of overlap and multiple overlap. These areas are important when considering load balancing and the TRIMAR's self-healing mesh features.

Load balancing and self-healing can only work in the areas with overlaps. So for example, if radio "E" goes offline or has reached its maximum loading, radios "C" and "D" can provide additional coverage in the immediate overlapping areas. Radios "A" and "B" can extend this further in the saturated service areas.

Wireless Mesh Basics

(../continued)

Why managed load-balancing is important:

If left to themselves, the radios deployed in the wireless mesh shown in Figure 7 and Figure 8 will do a decent job of providing even coverage in the service area covered. Problems can arise if, for example, the maximum numbers of stations have associated with a given TRIMAR AP (no other stations will be able to join the network in that immediate area) or too much bandwidth is being used by a few stations using the same TRIMAR AP (the connection speed can be significantly impacted negatively).

With the deployment of the TRIMAR CONTROLLER, these and other problems can be easily managed and overall operations optimized. So for example, if there are too many stations associated with one of the TRIMAR APs in the mesh, the network administrator can assign additional stations to other TRIMAR APs in the immediate service coverage area to more evenly distribute the load.

Extending the Mesh:

Each TRIMAR AP can “mesh” with up to six other radios. So how can a mesh be extended to cover a larger area or to provide built-in redundancy to an existing mesh to provide a more efficient wireless service? Figure 9 shows one way that this can be accomplished. Specifically by linking “E” to “F”. In practice, it would be prudent to build some “redundancy” into this type of extension by adding an additional route for the two separate meshes to intersect. Having a single route has the inherent danger that if either “E” or “F” should go offline, all other radios behind them will also be taken offline.

Note that in the extended mesh all the additional radios (“F”, “G”, “H”, “I” and “J”) can function purely as repeaters. No physical connection to the backbone LAN is required.

Wireless Mesh networks can offer significant advantages over traditional wired network architecture, especially in their ability to easily provide service to area hard to reach with hard-wired LAN connections.

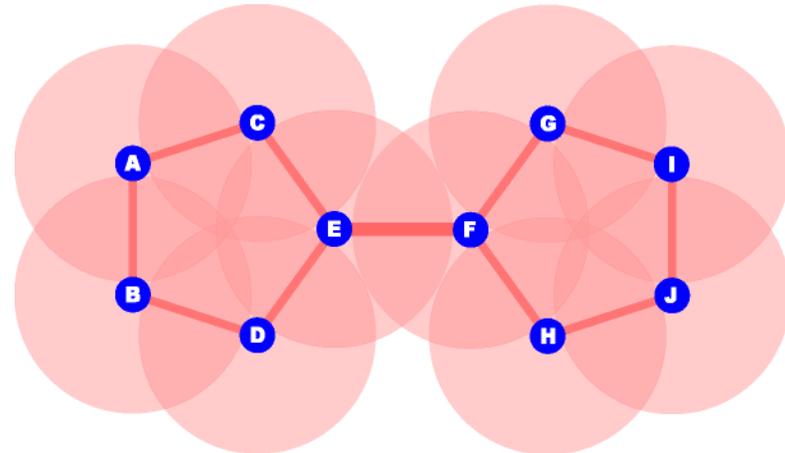


Figure 9: Extending the wireless mesh

TRIMAR SSIDs and MESH deployments:

WDS meshes created using TRIMAR APs do not require SSIDs. This means that separate SSIDs need to be created before individual stations can be incorporated into the mesh. As each TRIMAR AP can support up to 8 SSIDs, the permutation this allows permit network administrators multiple organization stratagems. As a basic consideration, at least one SSID should be common to all APs so that stations can join the network anywhere in the coverage area.

Incidentally, the mesh deployment in Figure 9 can in theory support up to 480 individual stations simultaneously with a combined total of 80 usable individual SSIDs.

With reference to Figure 5, the Branch Service Distribution Node can end with a wireless mesh as illustrated in Figure 8. This can provide service to 240 separate stations simultaneously over a much wider service area than can be reached via a single omni-directional antenna.

Meshes for commercial buildings

WDS Mesh example for multi-storey buildings

A properly designed wireless mesh offers not only easy network connections for multiple computing devices, but can be significantly more cost effective and cheaper than hard-wired LANs.

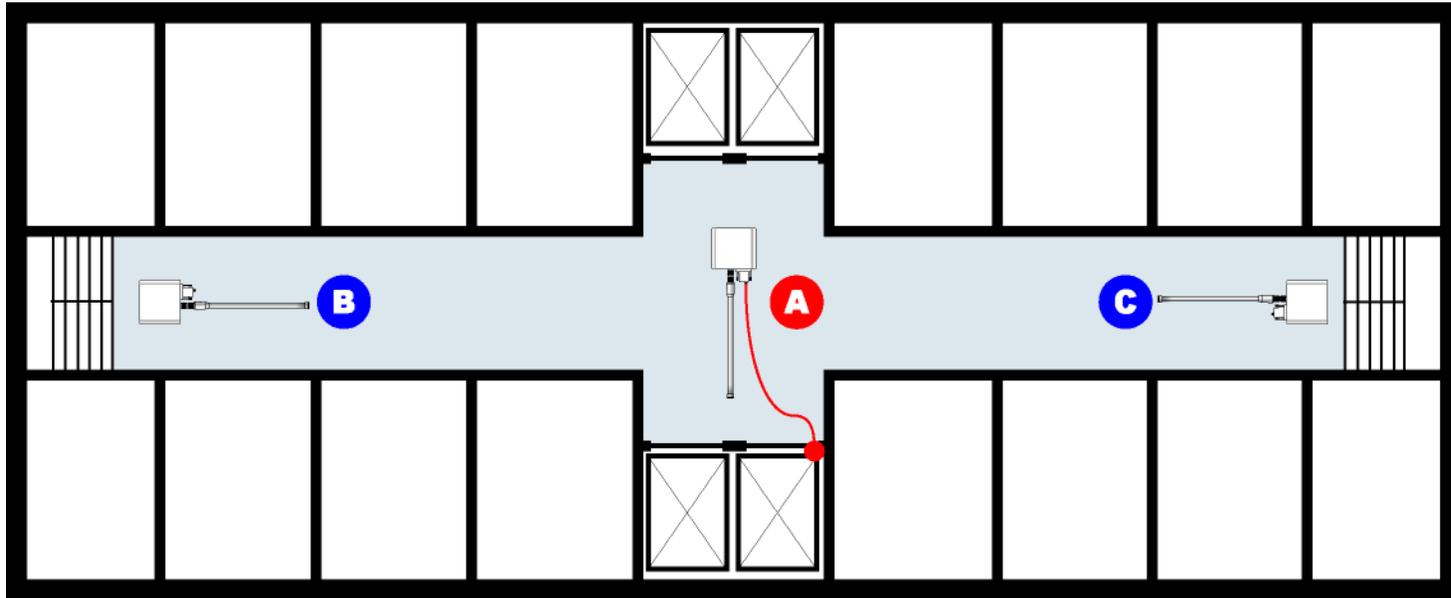


Figure 10: Simple wireless mesh for hotels, and other multi-storey buildings.

Wireless laptops, PDAs, Tablet PCs and other mobile computing devices have become everyday tools of the contemporary professional. As such, proper planning for mobile computing devices is an important part of any modern network function.

Most modern commercial buildings are built to maximize efficiencies including the inclusion of readily accessible conduits through the structure to carry building services such as computer cables. Trimar APs can be quickly deployed to take advantage of these service conduits as well as minimizing the need to add additional cabling.

TRIMAR AP at "A":

On every floor of Figure 10 there is only one TRIMAR AP connected physically to the backbone LAN. The cabling to the backbone LAN can be pulled through the existing lift/service shaft all the way back to the nearest main network switch or server room.

TRIMAR APs at "B" and "C":

To extend the wireless link across each floor, TRIMAR "B" and "C" are set into WDS mode to mesh with "A". However, "B" and "C" are not associated with each other, so in effect there are two interlocking meshes servicing each floor (mesh A-B and mesh A-C).

This type of mesh deployment is required for this type of application, as antennas do not provide wireless connectivity in all directions. They cannot broadcast signals in both the vertical and horizontal planes. Wireless waves also will have incredible difficulty penetrating through steel and concrete floors, which are the most common construction materials used in contemporary commercial buildings.

Note: 8dBi omni-directional antennas are illustrated in Figure 10. As deployed, these are more than sufficient to service a linear building the length of a football field.