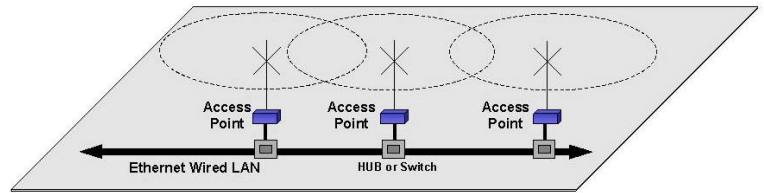


To increase the wireless network's area of coverage for both indoor and outdoor applications, the ESTeem 195Ep utilizes a custom repeating feature that allows increased coverage areas without the added expense of hard cabling or adding an additional point to point radio link. With a conventional IEEE 802.11g or 802.11b Access Point (AP) network, all of the APs have to be interfaced to a common network either by hardwire, see Figure 1, or a separate, dedicated RF backbone. The Model 195Ep can create this RF backbone, bridge Ethernet networks connected to the wired Ethernet port and provide the wireless canopy for 802.11 clients simultaneously.



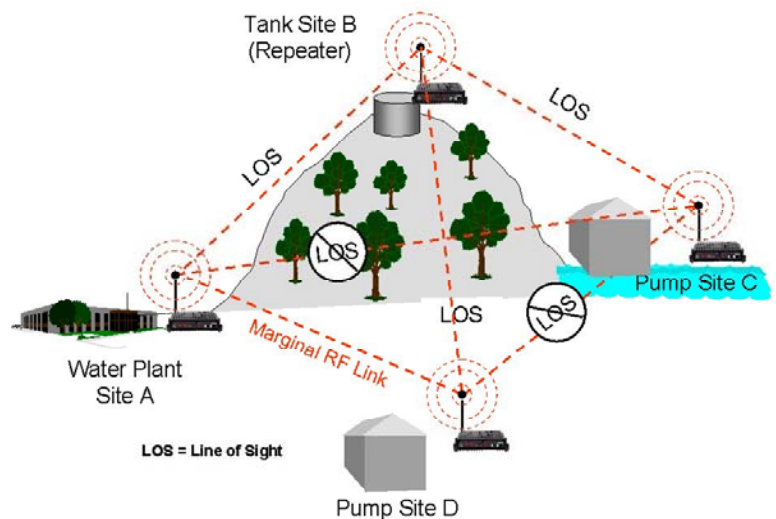
**Figure 1: Conventional Access Point Diagram**

When programmed in any of the three Access Point (AP) Repeater Modes, the Model 195Ep will create a wireless network with other Model 195Ep units in radio range that are programmed in the AP Repeater Peer table during setup. This feature adds the increased functionality of repeaters to the typical Ethernet Bridge configuration.

### ESTEEM MESH NETWORK

One of the most powerful features of the AP Repeater Mode is the ability to input multiple communication routes and designate the priority for each of these routes to create a wireless Mesh network. The ESTeem Model 195Ep will automatically change communication routes in the network if a route has failed. The new route will be based upon the priority level set during configuration. This wireless Meshing technology allows the RF network to "self-heal" if any of the communication paths fail.

The routing priority is manually set during the configuration of the 195Ep. A manual path configuration is far superior to standard "self-discovery" networks, because you have direct control over the best RF paths and can easily identify any failed routes for easy troubleshooting. For example, Figure 2 shows a typical wireless Ethernet system used in the Water/Waste Water Industry. The problem with a standard "self-discovery" Mesh network is the selection of routes. Notice that the communication between the Water Plant (Site A) and Pump Site D has a marginal link, but it is the most direct route between the Ethernet devices.



**Figure 2: Small Mesh Network Diagram**

This scenario poses the question, which path will the network select? The ESTeem Mesh Network takes out the guessing games by allowing the user to select and prioritize all communication routes in the system. In our example we would want the primary link to go through Tank B (Repeater) and use the direct link only if this primary link fails. The following sections will show how this completed.

### Configuration

The configuration of the repeater paths is completed during setup of the Access Point modes. All three Access Point modes support repeating and Meshing features. Figure 3 shows an example repeater peer table from the setup menus. For an ESTeem 195Ep to communicate with another ESTeem 195Ep, *Yes* must be selected at the "Enable Repeater Capability." Next, the Wireless LAN (WLAN) MAC address of each Model 195Ep that will have direct communications must be added to the Repeater Peer List. Finally, *enabling the link* allows the corresponding 195Ep to be included in the communication routing. Mobile clients

do not require input in the repeater peer table. If multiple Mesh routes are configured, you will also need to set the values for Priority and Path Costs (explained in Spanning Tree below). For multiple examples of repeater configurations, please refer to Chapter 5 of this user’s manual.

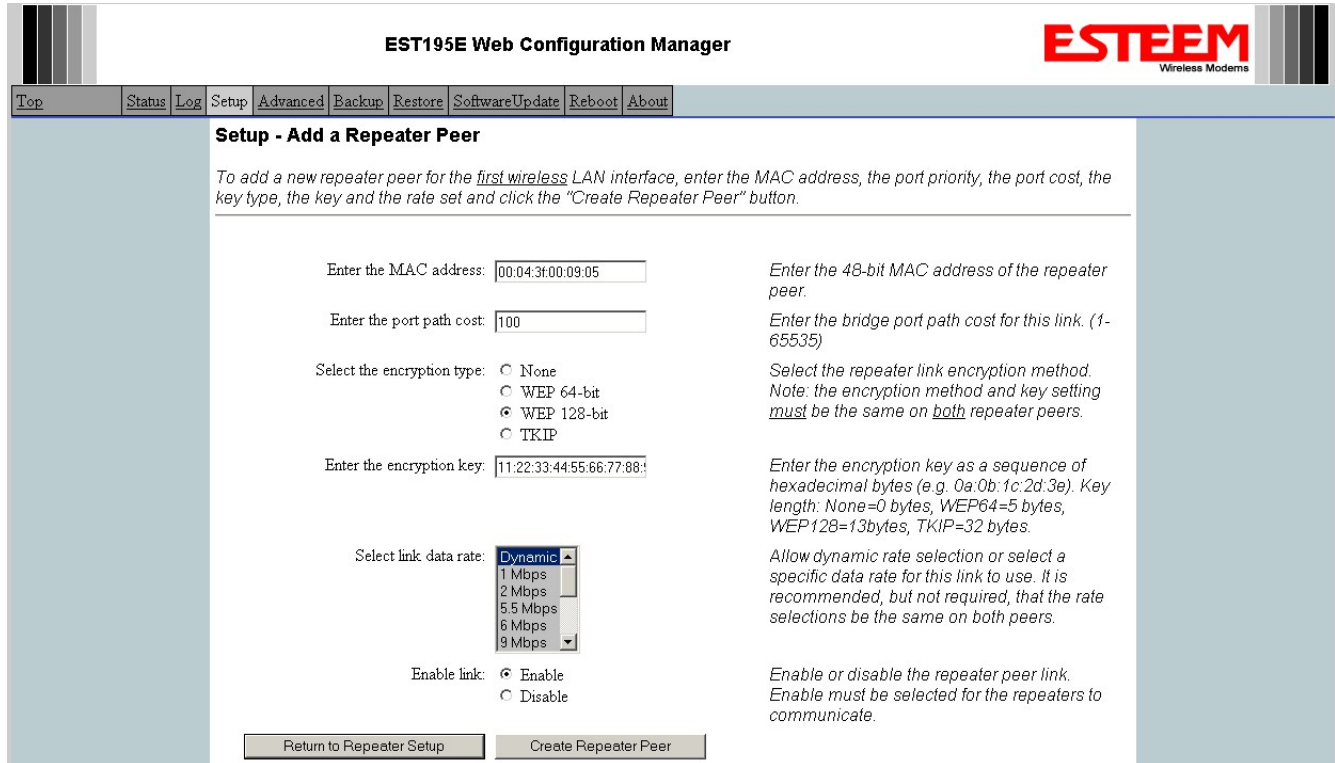
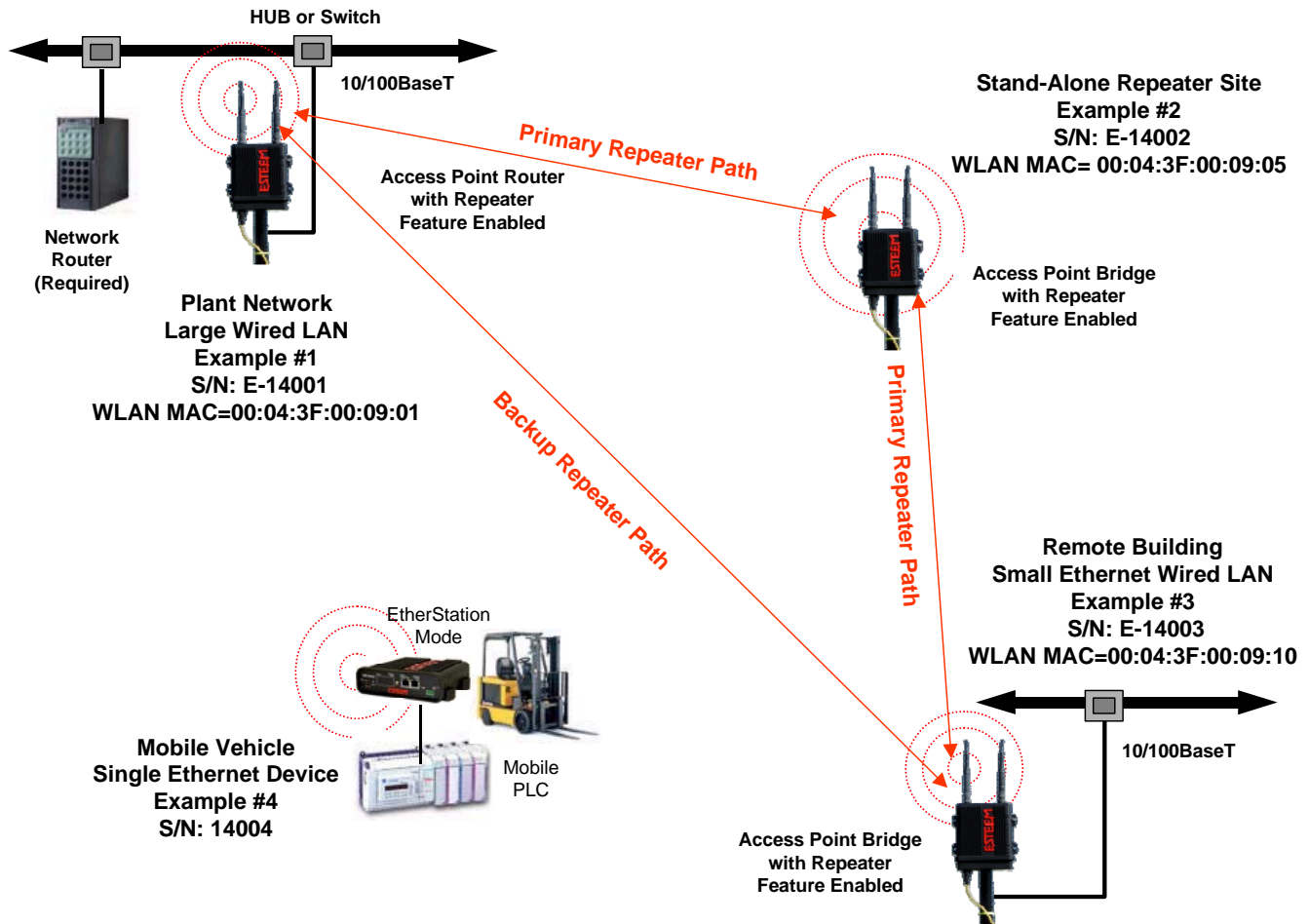


Figure 3: Repeater Configuration Example

### SPANNING TREE PROTOCOL (STP)

The ESTeem Model 195Ep uses standard Ethernet Spanning Tree Protocol (STP) to determine the radio routing structure of the wireless network. The primary purpose of STP is to make sure that “network loops” are not created. A network loop is having two communication paths to the same destination where the remote device would receive the same data multiple times. If there were no way to control the data flow, this data would be constantly passed around this loop causing a “packet storm” that would shut down the entire network. The Spanning Tree Protocol will block all these redundant links.

The STP operation begins by determining which Ethernet device on the network will be the Root Bridge. All Ethernet networks have a Root Bridge that is selected by the lowest MAC address. All path costs are evaluated against this Root Bridge device to determine routing and which paths will be blocked. On a wired Ethernet network, the location of the Root Bridge is not really important, but in a wireless network selection of the Root Bridge is critical to the wireless network routing. Let’s use one of the Example network diagrams from Chapter 5 to continue the discussion (Figure 4).



**Figure 4: Programming Example #1 Diagram**

The following sections describe the process of the STP in the ESTeem Model 195Ep as how it would happen in the above example.

**Learning Phase** - Once properly configured, each Model 195Ep will begin to search out the other Model 195Ep units in radio range that are programmed in the AP Repeater Peer table. All Model 195Ep's will calculate their routes to every Model 195Ep in the network based upon the lowest "path cost" to the Root Bridge. Path cost is the total cost of transmitting a packet through the wireless network to the Root Bridge. **Note:** *The Root Bridge in a network should be the Model 195Ep where the majority of the data flow is processed.* In every wireless network of two or more radios, the Root Bridge should be user defined. If not defined, the ESTeem 195Ep with the lowest MAC address will be designated as the Root Bridge.

In Figure 4, the Plant network (Example 1) is the most logical location for the Root Bridge based upon the amount of data flow. Setting this site as the root bridge is discussed below in Root Bridge.

**Blocking and Forwarding Phase** – To ensure you do not have a network loop situation due to redundant paths in your wireless network, the Model 195Ep will recognize and disable (block) one or more redundant links and provide back up links should the primary link fail. This establishes a wireless mesh network with a series of forwarding links, based upon the shortest path cost to the Root Bridge.

For example, looking at Figure 4, the Remote Building has two routes to the Root Bridge (Plant Network – Example #1); directly to the site and through the repeater. The direct link between the two sites is the shortest route (lowest Path Cost) and will be selected as the primary route unless overridden by manually changing the Path Cost in the configuration.

### Path Cost

If more than one communication path to the Root Bridge is found, the 195Ep must determine which route to take based upon the lowest Path Cost. The default path cost to all links in the 195Ep network is 100. If the Path Costs are equal then the lowest MAC address will determine the priority route. In the ESTeem Mesh Network we want to directly control all data flow so do **not** want the routes to be automatically determined.

Looking again at our Example in Figure 4, if we made no changes to the default path cost of 100 (note values in Figure 3) the lowest path cost would be direct from the Remote Building to the Root Bridge (Plant Network).

Link Description	Number of Routes	Total Path Cost
Direct from Remote Building	1	100
Remote Build to Root Bridge Through Repeater	2	200

To configure the 195Ep to select the repeater as the primary radio path, set the path cost value for the direct link greater than 200 to make this the primary radio path. The lowest path cost will identify the highest priority. The Model 195Ep will use this routing, but also switch to direct communication if the repeater were to disappear.

### Root Bridge

In any Access Point Repeater network consisting of more than two sites, one Model 195Ep should be designated as the Root Bridge. Only one Model 195Ep can be designated as the Root Bridge in a given network and should be located where the majority of the Ethernet data flow is processed. This site may be the Master location in a SCADA network or could be configured at a repeater site. Selection is important because all Model 195Ep's NOT configured as the Root Bridge will choose routing based upon the Path Cost to the Root Bridge. If you have any question as to which site in your AP Repeater application should be the Root Bridge, contact ESTeem Customer Support at 509-735-9092 or e-mail your application to [support@esteem.com](mailto:support@esteem.com).

The Root Bridge will be selected in one of two ways: the Root Bridge can be manually set (recommended) during the configuration of the Repeater Peer table (Figure 3) **or** the Root Bridge designation will default to the lowest MAC address of all the Model 195Ep's in the network. The manual Root Bridge configuration is located in the "Advanced Settings" section.

The screenshot shows the 'EST195E Web Configuration Manager' interface. At the top, there is a navigation menu with options: Top, Status, Log, Setup, **Advanced**, Backup, Restore, SoftwareUpdate, Reboot, and About. The 'Advanced' tab is selected, and the 'Setup' section is active. Below the navigation, there are instructions about enabling repeater capability and setting it as the root bridge. Two radio button options are visible: 'Enable the repeater capability?' (Yes selected) and 'Set as root bridge?' (Yes selected). Below these is a table titled 'Repeater Peer List' with columns: MAC Addr, Port, Priority, Path Cost, Encrypt Type, Data Rate, and Enable. The table contains two entries: one with MAC 00:04:3F:00:09:05, Port 128, Priority 100, Path Cost 100, WEPI28, Dynamic, and true; and another with MAC 00:04:3F:00:09:10, Port 128, Priority 201, Path Cost 201, WEPI28, Dynamic, and true. To the right of the table are buttons for 'Add', 'Remove', and 'Modify'. At the bottom of the configuration area are 'Previous' and 'Next' buttons.

Figure 3: Repeater Configuration Example

### Redundant Backup

The ESTeem Model 195Ep configured in Access Point Repeater mode will automatically function as a redundant backup if two Model 195Ep's are installed at the same location (Figure 7). If two Model 195Ep's are connected to the same HUB or Switch, one of the Model 195Ep's will be **Blocked** when the Spanning Tree Protocol is completed. The network will continue to use this route until any problem with the original Model 195Ep is detected and the second Model 195Ep will begin operation at that site.

**Redundant Master Configuration** – The configuration in Figure 7 will also provide a redundant backup for the Master Site (Root Bridge). Configure both Model 195Ep's as Root Bridges (see above) giving the primary Root Bridge a value of 1 and the secondary Root Bridge a value of 2.

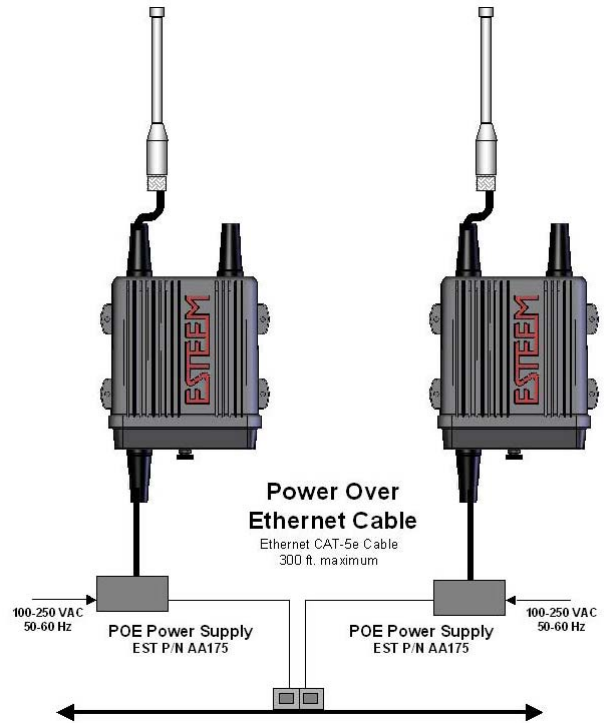


Figure 7: Redundant Backup Diagram