# LAN/WAN Considerations for Commercial Installs

In this application note, we'll discuss the following topics:

- Envoy Communications
- Typical Commercial Network Setups
- Enphase Commercial Deployment Examples
- Wireless Technologies
- Network Basics and Troubleshooting

Envoy Communications

With all Enphase installations, communication between the array and the Envoy™ Communications Gateway is key to system monitoring and maintenance. The Enphase Energy Envoy communicates with the microinverters in the solar array via the premises power-line wiring. The Envoy then communicates with the Enphase Enlighten™ Monitoring and Analysis site via its LAN (Local Area Network) cable, connected to the premises broadband Internet connection.
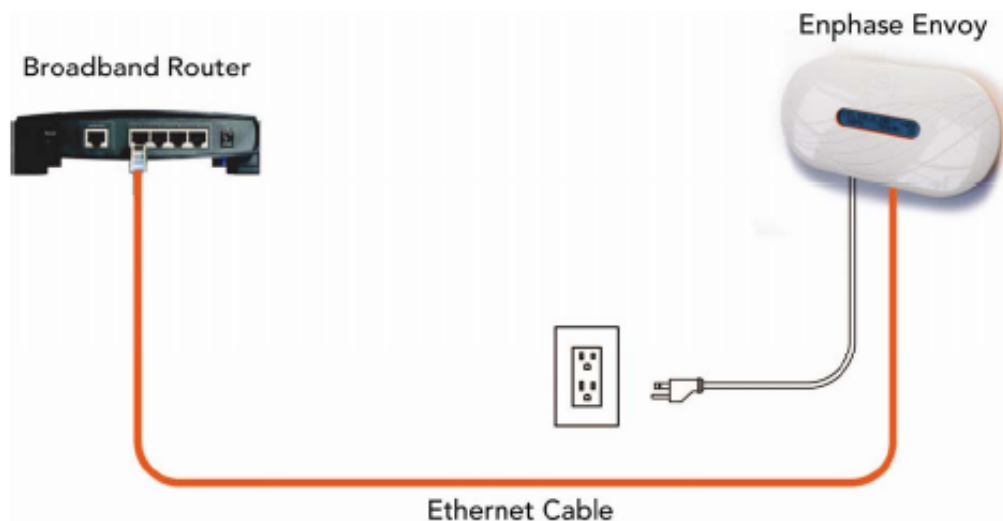
The Envoy, in this sense, acts just as another computer in the house or business, connecting through a standard Ethernet LAN cable and using standard TCP/IP protocols.

While it is a trivial task to make this connection in a residential setting, the commercial installation usually requires additional considerations.

Envoy Capacity

In installations with fewer than 250 microinverters, a single Envoy can be used. However, in larger commercial installations, the number of addressable Enphase Microinverters usually exceeds the capacity of a single Envoy (up to 250). In installations requiring multiple Envoys, "LCF Envoys" must be used. Each LCF Envoy manages up to 180 microinverters. Therefore, the commercial integrator will build the site based on building blocks of up to 180 microinverters and one LCF Envoy and increase those multiples to complete the size of the overall installation.

LCF: Line Communications Filter

Where multiple Envoys are deployed, each LCF (Line Communications Filter) enclosed Envoy isolates the power line communications between one group of microinverters with one Envoy and any other co-located group of microinverters and Envoy.
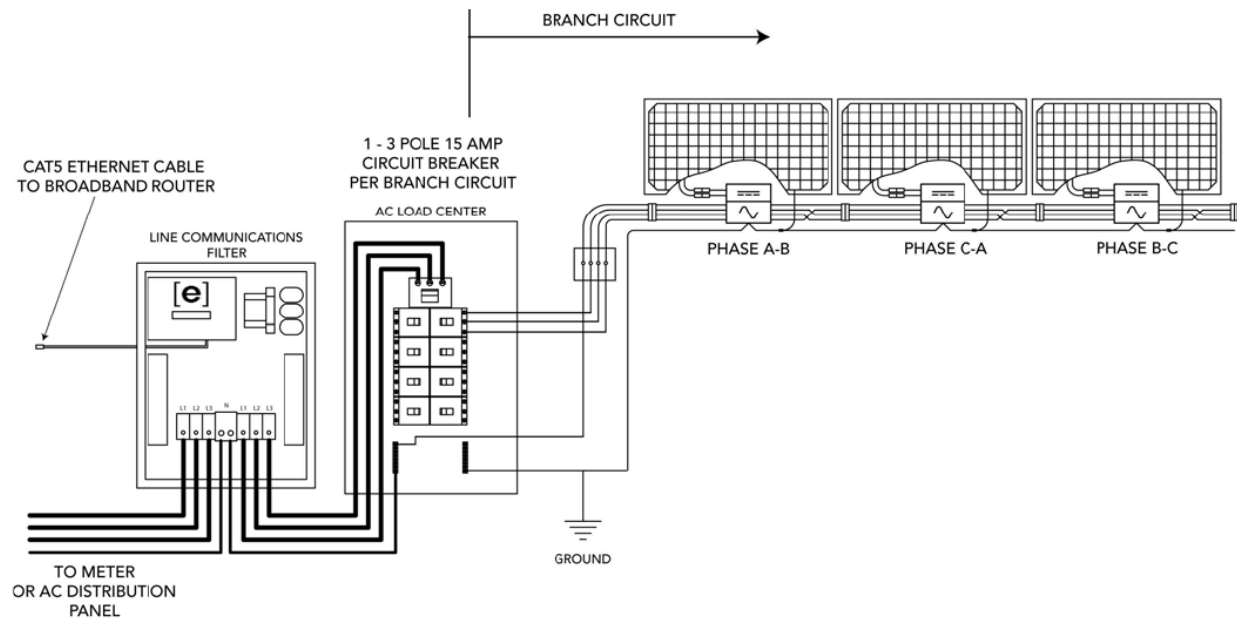
The LCF contains terminations for phase conductor lines in and out. By running phase conductors through the LCF, the Enphase 144kHz communication signal is filtered out.

The LCF contains an Envoy, as well as a single electrical receptacle for powering it, as shown in the following photo:
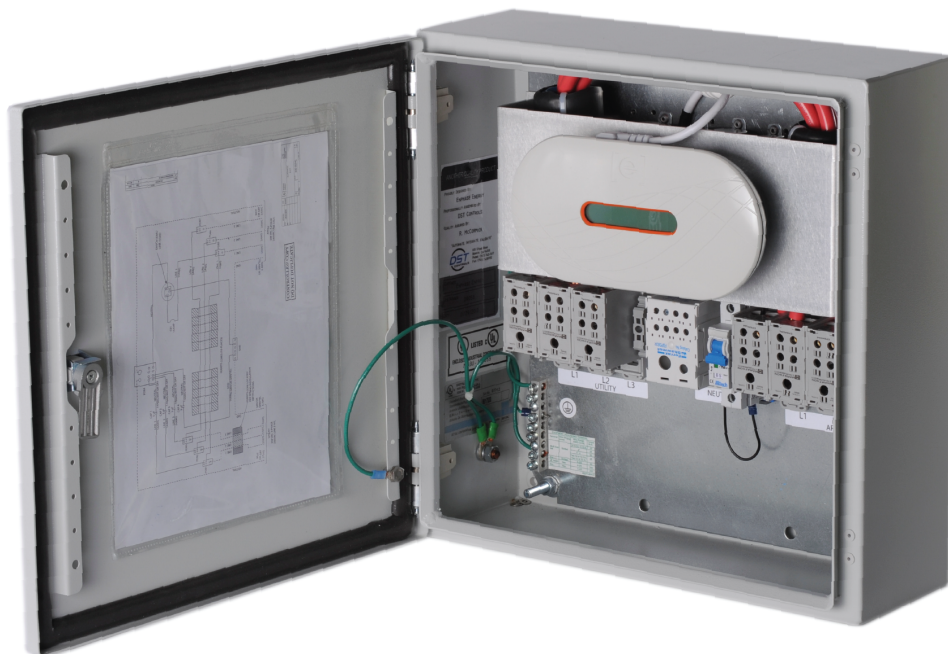
Single-Line LCF

The single-line diagram for the LCF is shown below:

Note that there is a reference to the LAN/Ethernet cable coming into the LCF enclosure, which then plugs into the Envoy's Ethernet port. The other end of that Ethernet cable connects to an Ethernet switch or router in a network infrastructure, which ultimately leads to an Internet connection.

Note that there is no master/slave networking architecture. Each Envoy device must be independently connected to an upstream Internet port.

Envoys plugged into a networking switch or router is no different in this context than a computer or laptop plugged into a networking switch or router. It uses the same CAT5 Ethernet cable that any other computer would use.

Typical Commercial Network Setups

Typical Ethernet Network Topology - Residential

In a typical residential networking setup, the LAN (Local Area Network) portion is what is on the "inside" of the local network. In the diagram below, that would encompass Computer-A, Computer-B, Notebook-C and the Router.
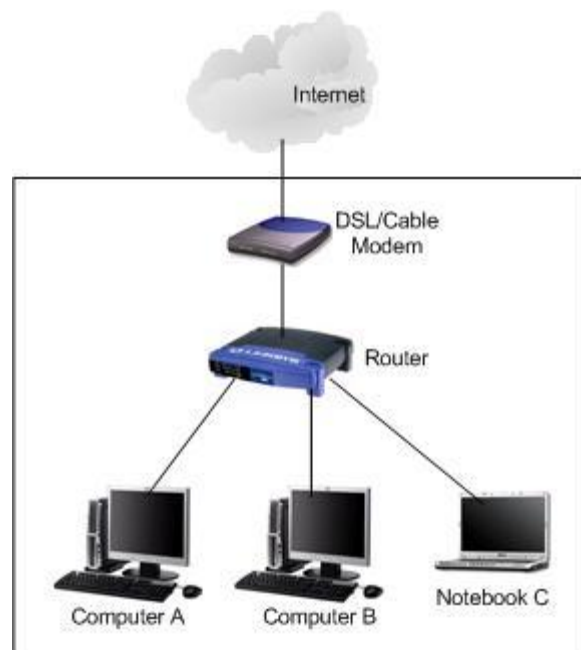

The WAN (Wide Area Network) portion is what is on the "outside" of the local network. In the diagram above, that would encompass the "WAN" port of the Router and the DSL/Cable Modem. The WAN is the upstream connection to the Internet.

The Router may also include wireless (WiFi) services, and there may be one or more laptop computers in the residence that access that Router via WiFi.

Typical Ethernet Network Topology – Commercial

The typical, commercial LAN/WAN setup is a little more involved, but the components are the same. The diagram below reflects a typical, small commercial network design.
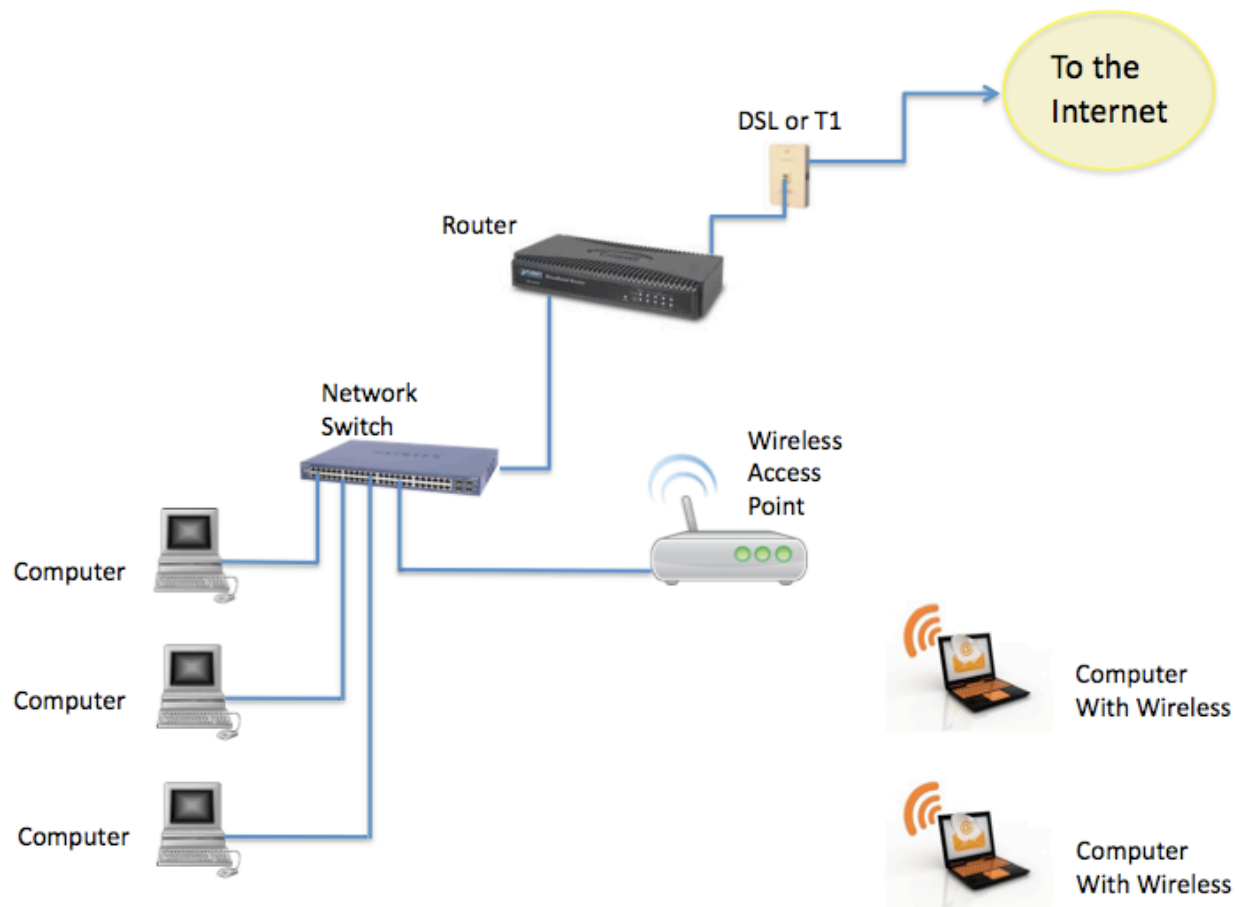

The computers are connected to the Network Switch via standard Ethernet cables. The computers with wireless (WiFi) capability access the LAN via a separate Wireless Access Point, which itself is connected to the Network Switch.

The Network Switch is connected upstream to the Router. The Router then plugs into the wall-plate where the commercial business has a DSL or T-1 connection to the Internet.

Typical Ethernet Network Topology – Commercial with Enphase Envoy

The diagram below replaces one of the computers with an Envoy network-gateway device from Enphase. The Envoy connects to the wired LAN just like another computer would.
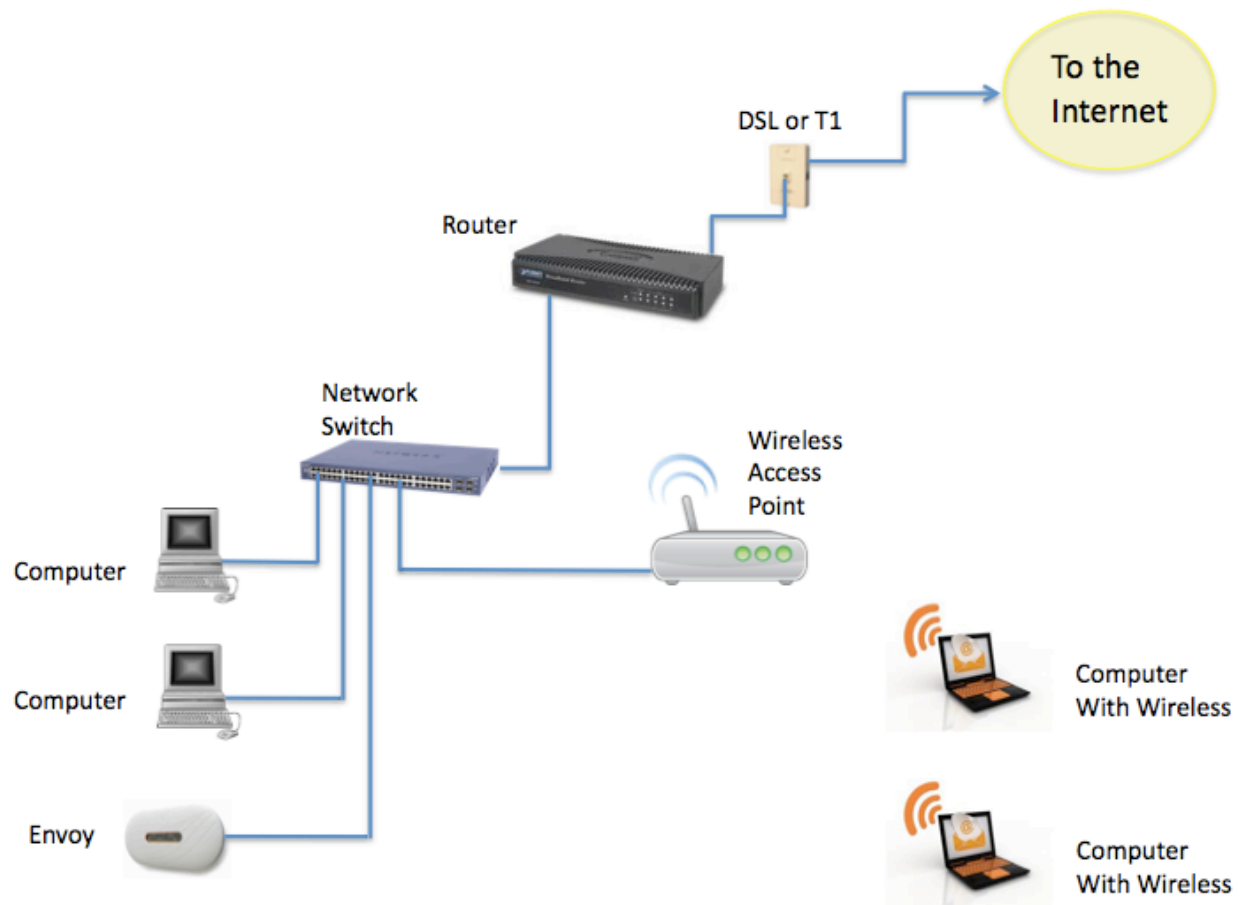

The Commercial business would most likely have multiple Envoys, each with its own independent Internet connection.

Enphase Commercial Deployment Examples

**Typical Enphase Energy Commercial Deployment – Single LCF**

If you now take what you know about LAN/WAN in a Commercial setting and picture the Envoy up on the roof, inside the LCF, near the solar array(s), the model should look like the diagram below.
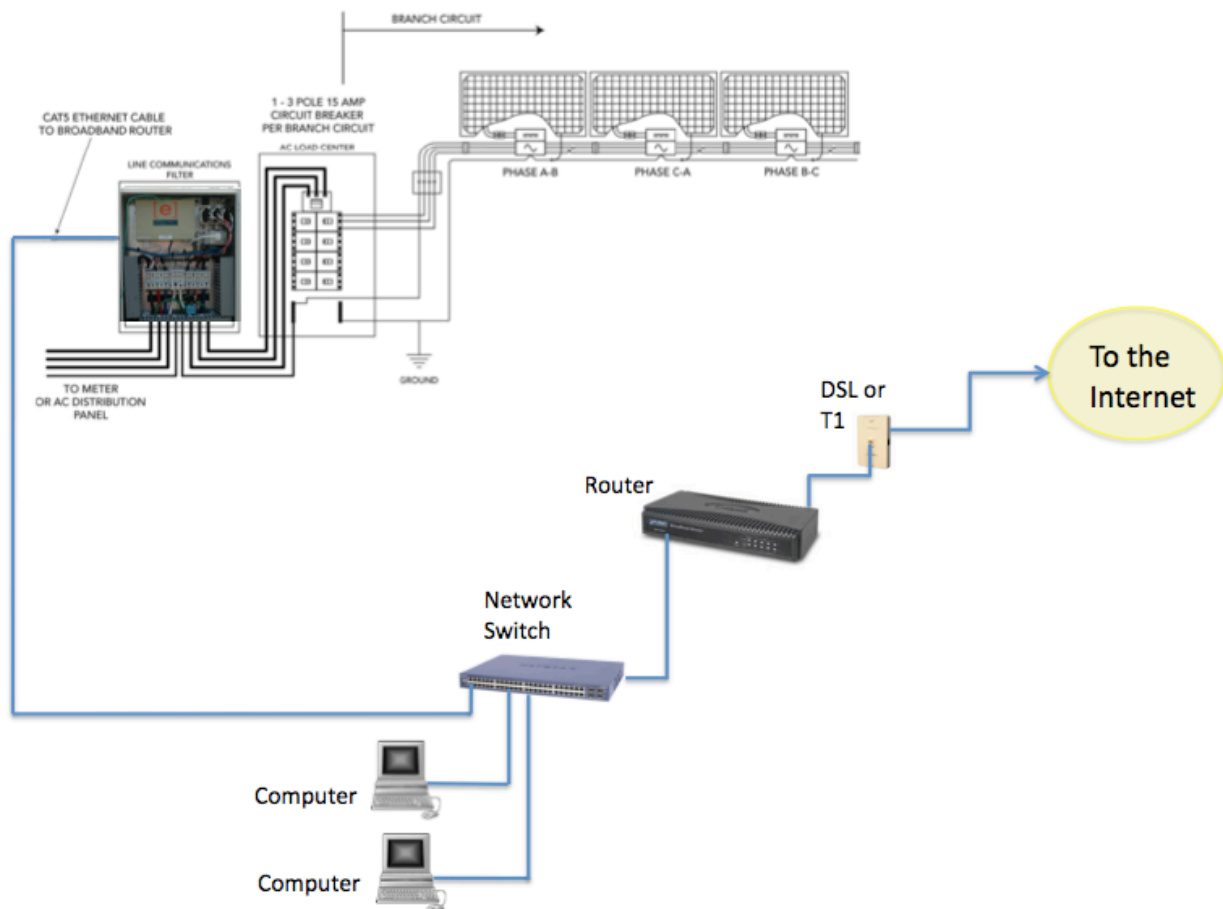
Note that the Envoy is mounted inside of the LCF enclosure, but still needs a standard Ethernet cable to an upstream Internet connection.

Typical Enphase Energy Commercial Deployment – Multiple LCFs

Now picture multiple LCFs, each with a built-in Envoy. Each of those Envoys communicates (via the power lines) with its own collection of microinverters. Each collection of microinverters is called a communications "domain". The diagram below shows two LCFs, each with their own microinverters and attached photovoltaic (PV) modules.
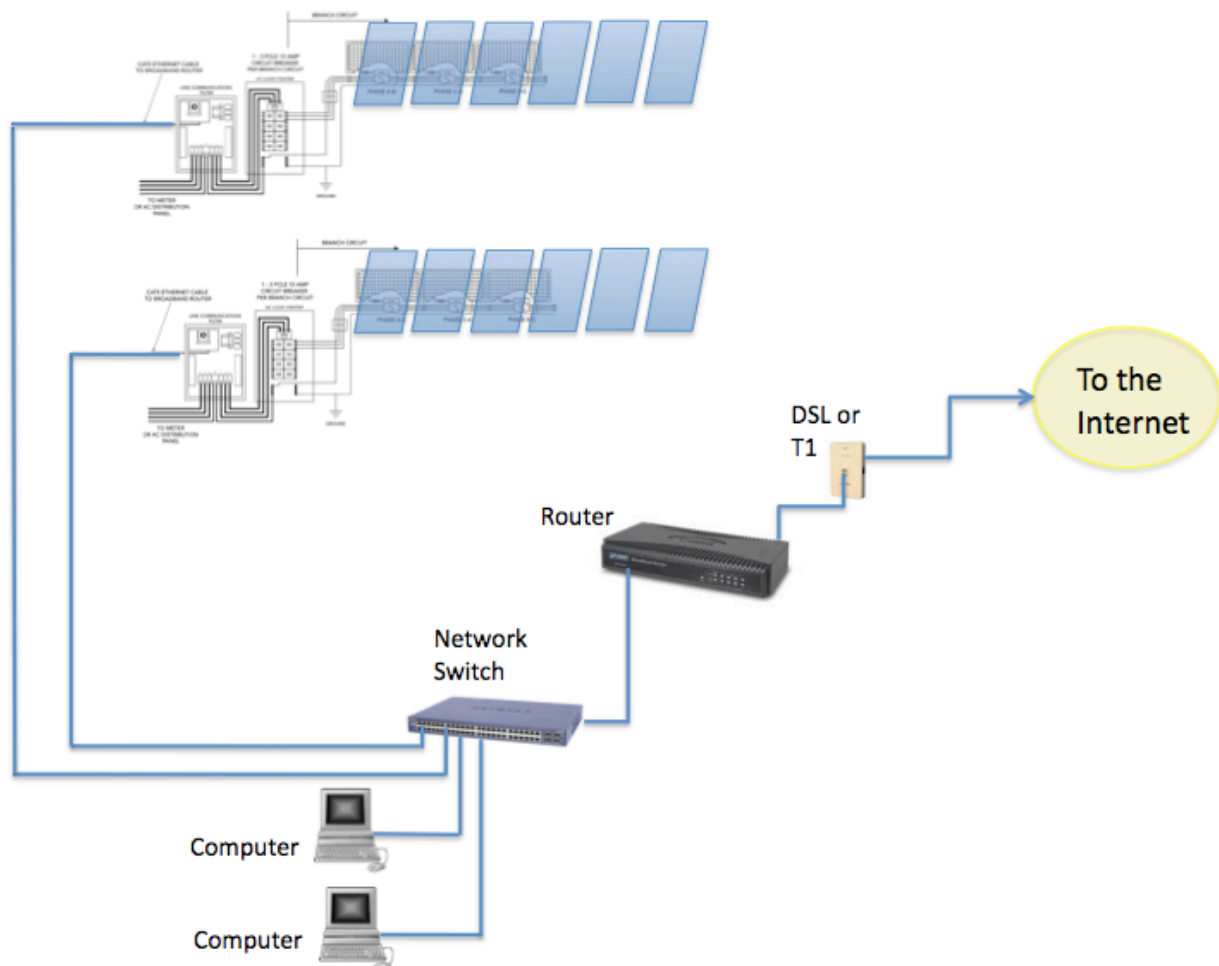

This model can scale as large as you need. For another collection of fewer than 180 microinverters, add another LCF with built-in Envoy to build discrete groups (LCF+Envoy+Microinverters) each in their own communications domain. Using the filtering mechanism of the LCF, the power line communications from one communications domain is isolated and separated from any others.

Sample Enphase Energy Commercial Deployment Ethernet Network using a Wireless LAN

In Commercial deployments, the installer may want to use a Wireless Access Point to provide Internet connectivity to one or more of the Envoys inside of the LCF enclosures.

This way, only the Wireless Access Point needs the hard-wired connection to an Internet switch/router. In turn, it provides WiFi services to each of the Envoys.

The Envoy does not have wireless capability built-in, so each one would require its own Wireless Ethernet "Bridge" to pass data from the Envoy to the Wireless Access Point as shown in the diagram below.
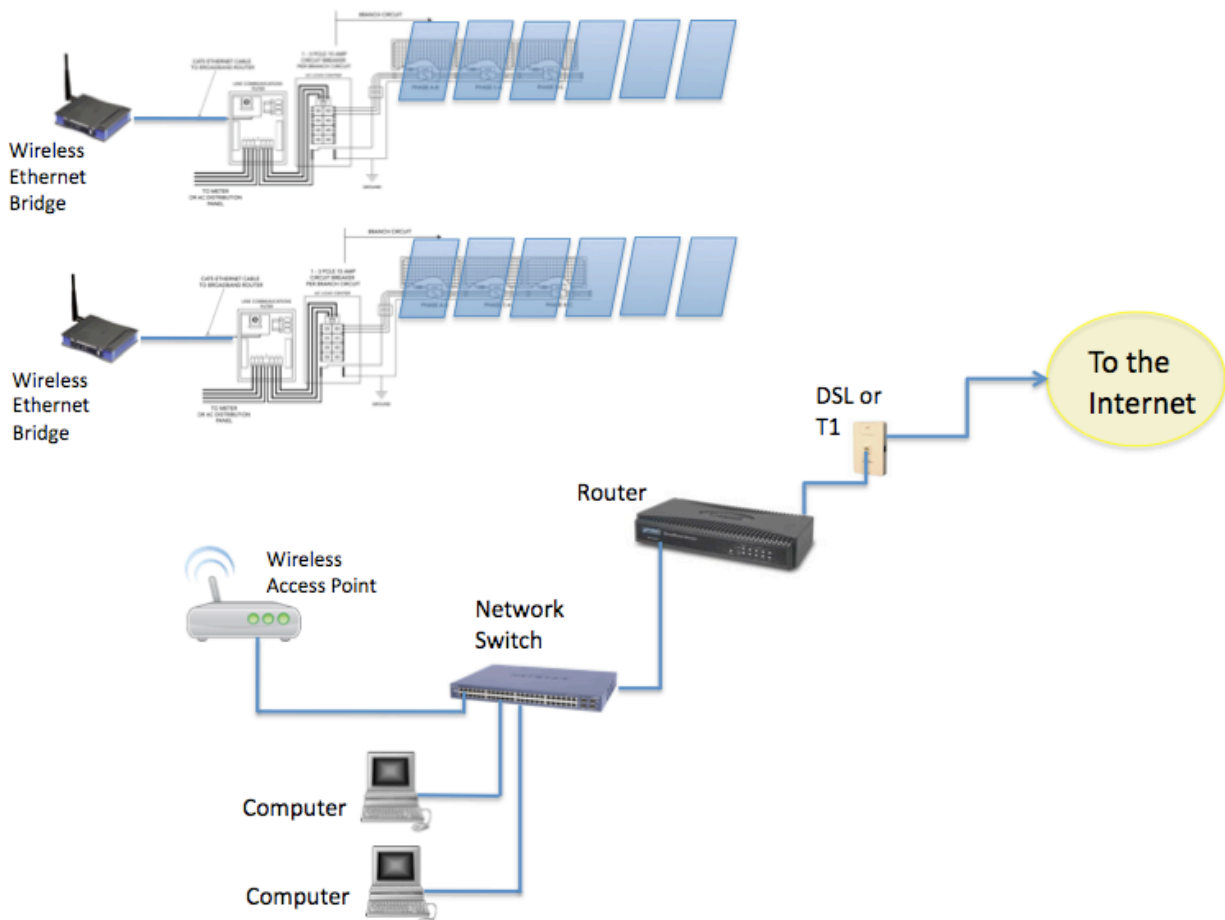
Wireless Technologies

Consumer-grade WiFi devices have varying ranges of operation. Not all WiFi vendors specify the unobstructed distance for which their product will provide wireless coverage.

Wireless specification 802.11g is the current standard, with 802.11n recently ratified. Check vendor specifications for claims of distance/coverage, and remember to factor in obstructions, such as buildings, walls, etc.

Wireless Vendors:

- Linksys: http://home.cisco.com/en-us/wireless/linksys/
- Netgear: http://www.netgear.com
- Ubiquity Networks: http://www.ubnt.com/
- Meraki: http://meraki.com/

Wireless Routers

WIFI routers provide a wireless gateway to the Internet. Wireless vendors Linksys and Netgear produce WIFI routers that are installed in large numbers and that are solid and reliable. Units come with installation DVDs for easy setup, have excellent documentation, and come with phone/online technical support.

Wireless Ethernet Bridges

A wireless Ethernet bridge converts a wired Ethernet device for use on a wireless network. (Think of it as an external wireless network card). The Linksys WET610N and Netgear WNCE2001 are often recommended.

Wireless Hi-Gain Antenna Systems

Wireless Hi-Gain Antenna systems are for use when the distance from the LCF to a wireless router is over 500ft. Ubiquity Networks directional Nanostation 2s are recommended. The system is made for outdoor use, and a variety of mounting brackets are available. Configuration is accomplished through a web interface and a number of tools are available to verify signal strength between devices.
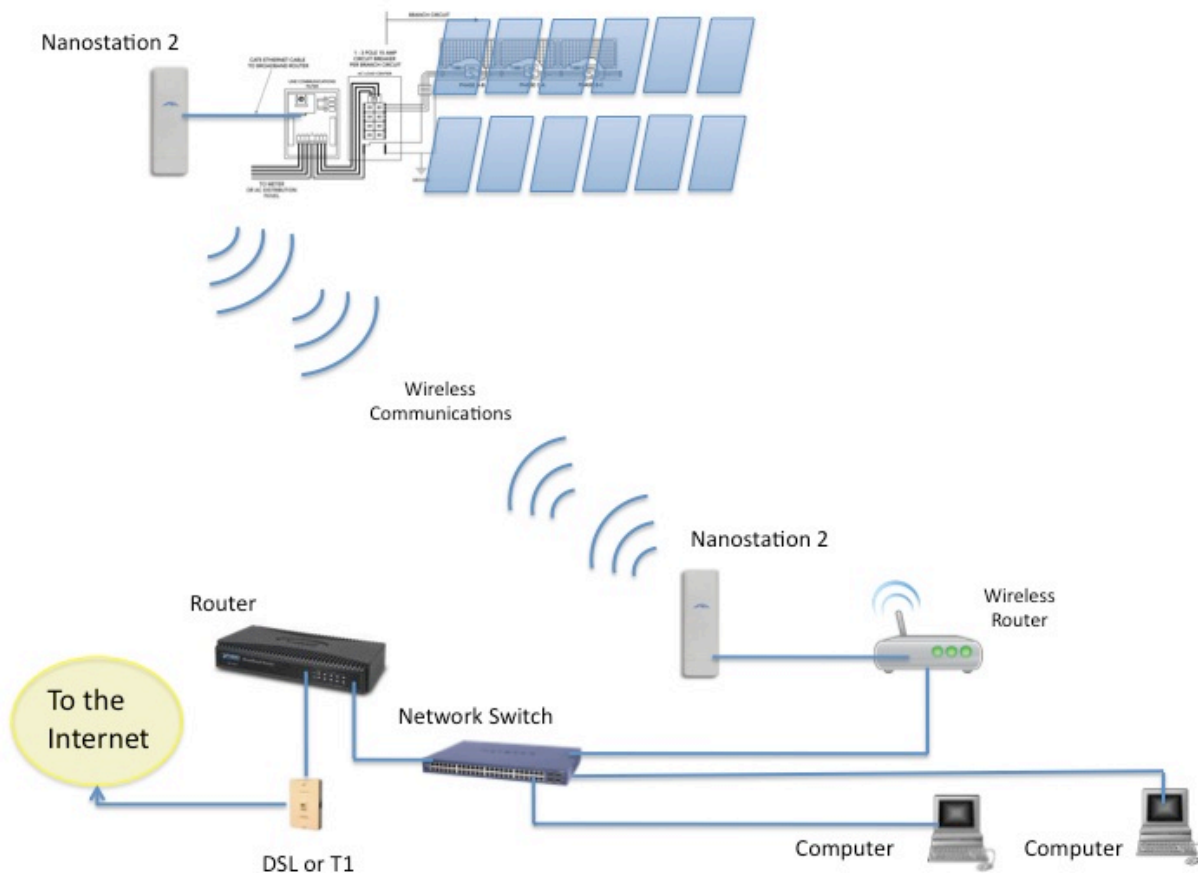
Wireless Mesh Network

A wireless mesh network is a communications network made up of multiple wireless bridges and antennas organized in a mesh topology. This topology would be used at sites with multiple buildings, where cabling would be extremely difficult. Ubiquity Networks makes a weather-proof Nanostation 2 with PicoStation M units. Meraki Networks also makes a weather-proof unit called the OD2, which is an Omni-directional WIFI access point. The OD2 can to connect an LCF and transmit a signal to extend reach to other OD2 devices.
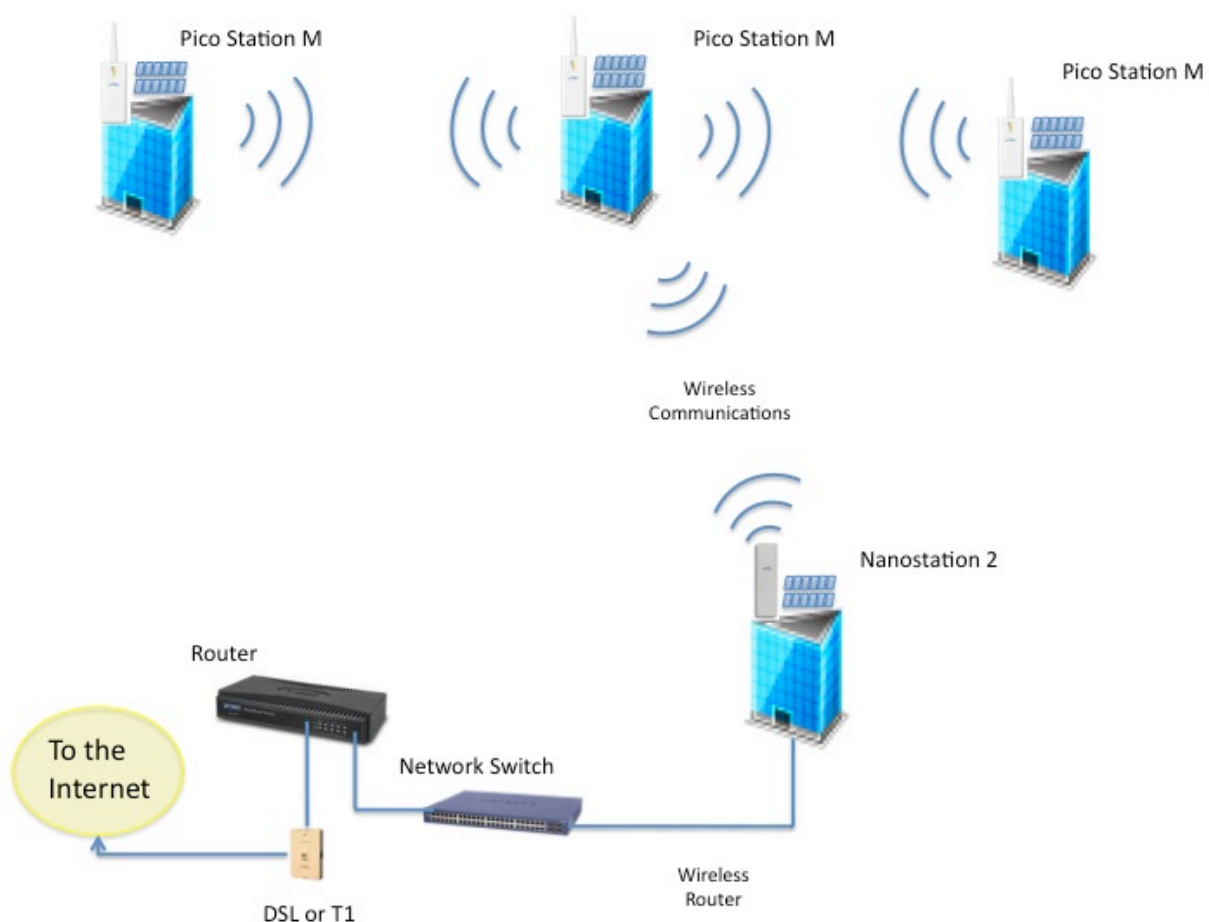
Network Basics and Troubleshooting

DHCP and Self Assigned IP Address (169.254.x.x)

When the Envoy first boots up, it is configured to perform a DHCP (Dynamic Host Configuration Protocol) broadcast, requesting an IP address from a DHCP source. This source can be a server/computer, but almost all consumer-grade broadband routers also provide DHCP services as well, and this is the usual source of IP addresses for network hosts (computers, laptops, and the Envoy).

If the LCD window of the Envoy displays an IP address beginning with "169.254.", this means that it was unable to receive an IP address from a DHCP source, and so it assigned this address to itself. Check your Ethernet cabling and check that the router is providing DHCP services.

MAC Filtering

Check to see if "MAC Filtering" is in use at the site. This has nothing to do with Apple Macintosh computers, but rather, refers to the MAC (Media Access Control) address that each individual network card possesses. The MAC Address is a 48-bit address, which uniquely identifies that piece of hardware. MAC Filtering, then, is a security mechanism by which routers allows administrators to specify which devices can use the router for access to the Internet. This prevents unauthorized/unknown personnel from using your router to get to the Internet.

An example of a MAC address would be:

   00:17:F2:D6:B1:45

MAC addresses contain six (6) pairs of characters, including any number 0-9 and letters A-F.

The MAC address of the Envoy will begin with:

   00:D0:69:41:

You will need to identify the specific MAC address of your Envoy for the purpose of adding it to list of authorized devices on the router. To do this, browse to the home page of the Envoy's web-service using an ordinary web-browser. The home page contains that specific Envoy unit's MAC address. The MAC address is also located on a sticker that is located on the back of the Envoy.

Firewall Settings

The Enphase Envoy requires **OUTBOUND** access using the **HTTPS** protocol. This may be restricted via firewall rules at the site's Internet router. Generally speaking, these routers allow, by default, all OUTBOUND connections but restrict any/all INBOUND connections.

If you discover that there are outbound, firewall rules applied at the site, then you must setup a new rule that allows outbound TCP port #443 (HTTPS protocol) to the destinations of both "reports.enphaseenergy.com" and home.enphaseenergy.com.

If you have enabled firewalling on the broadband Internet router, enable the following rules:

Direction	Source	Protocol	Port	Destination
OUT	<Envoy IP address>	TCP	443	reports.enphaseenergy.com
OUT	<Envoy IP address>	TCP	443	home.enphaseenergy.com
OUT	<Envoy IP address>	TCP	123	us.pool.ntp.org