

Pharos AP Solution 3

CPE&WBS Outdoor Wi-Fi Solutions for WISP Applications

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Background

The internet has become a basic requirement for homes and businesses worldwide. Wireless networks cover nearly every corner of our cities, allowing people to get online anywhere, anytime. Getting an internet service to remote or rural areas, however, can prove challenging via a traditional wired network. WISP (Wireless Internet Service Provider) networks can provide a solution by reaching isolated areas through wireless internet. TP-Link's Wi-Fi solutions for WISPs use our Pharos series products to construct cost-effective wireless networks that combine high performance with easy setup and management.

Application Scenarios

- Wireless broadband access for ISPs (Internet Service Providers)
- Connect a headquarters with multiple subsidiaries in an area through a P2P (point-to-multipoint) wireless link to a remote base station, followed by a P2MP (point-to-multipoint) connection with multiple access points. .

Benefits

- 1) Cost-effective solution with a rich array of features
- 2) Simple deployment, management and maintenance, as well as high stability and reliability
- 3) Experienced and reliable technical support

Solutions

Network topologies for WISPs consist of two parts:

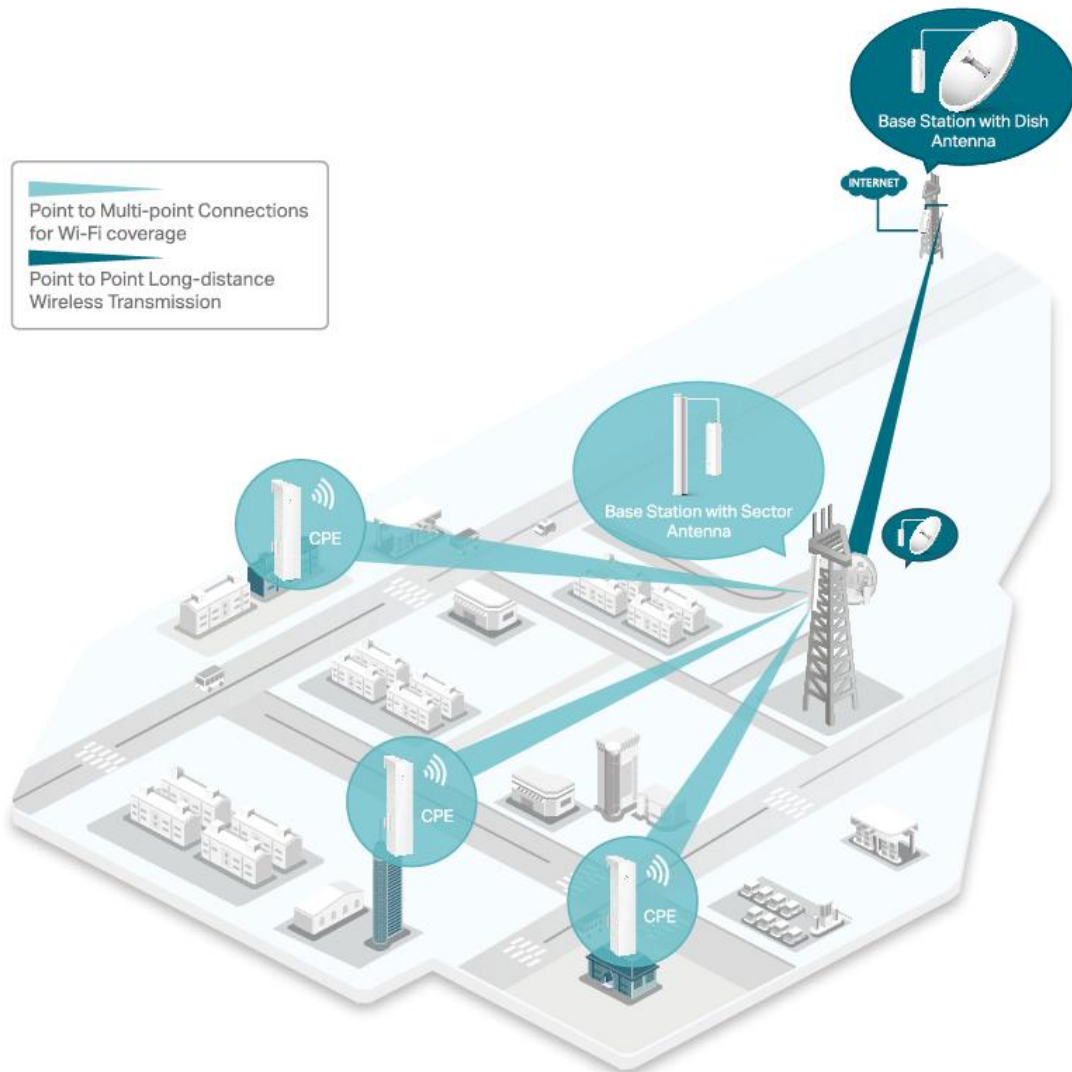
- 1) P2P Backhaul, providing a backbone connection for remote wireless access.
- 2) P2MP Access, providing network access for multiple clients. This article will introduce wireless networking solutions for WISPs based on TP-Link Pharos CPE and WBS products.

The solutions include three parts:

- A. Solution Overview and Network Topology Description.**
- B. Network Deployment and Configuration Guide.**
- C. Wireless Network Optimization.**

A. Solution Overview and Network Topology Description

Networking Solutions —Outdoor Wi-Fi Solutions for WISP Applications Based on CPE and WBS



As shown above:

1. Deploy WBS + Dish Antenna at both the remote ISP station and central base station, and create the long-distance backbone connection wirelessly (P2P Backhaul), with a distance of up to 40km+.
2. Deploy WBS + Sector Antenna at the central base station and connect to WBS + Dish Antenna for mid-distance wireless network coverage, with a 120° angle of coverage and range of more than 15km.
3. Deploy CPEs at the users' end which connect to the remote base station network to receive internet access (P2MP Access).

B. Network Deployment and Configuration Guide

1. Network Deployment and Configuration Guide 1: Solution Selection

TP-Link provides outdoor Wi-Fi networking solutions, including P2P Backhaul and P2MP Access, for WISPs based on our Pharos series (CPE and WBS products).

Backhaul networking solutions include Economic (deploying CPE products as a P2P wireless link) and Enhanced (deploying WBS products as P2P wireless link):

Solution	Economic	Enhanced
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Product	CPE	WBS + Dish Antenna
Distance	0-20km	0-40km

In general, most WISP programs adopt the Enhanced solution based on WBS + Dish Antenna with the following advantages:

- 1) Concentrated coverage, less wireless interference, and longer distances
- 2) More stable network and higher throughput compared with CPE over the same distance

Access networking solutions include Economic (CPE) and Enhanced (WBS) too:

Solution	Economic	Enhanced
Product in AP side	CPE	WBS + Sector Antenna
Product in Client side	CPE	CPE
Horizontal Coverage Angle	45°-65°	120°
Recommended Distance	0-15km	0-15km

In general most WISP programs adopt solutions based on WBS + Sector Antenna with the following advantages:

- 1) Wider coverage, longer distance communication and better performance
- 2) Simpler antenna alignment since the Enhanced Solution has a wider angle of coverage than the Economic solution

2. Network Deployment and Configuration Guide 2: Introduction to Pharos

TP-Link Pharos series include three types of products: CPE, WBS and MIMO Antenna. This article will make a brief introduction to them. For detailed information, please refer to the [CPE&WBS](#) and [MIMO Antenna](#) pages on our website.

CPE is an access point device and has built-in directional antennas. So far there are four models of CPE: CPE210, CPE220, CPE510 and CPE520. The specifications are as follows:

Model	CPE210	CPE220	CPE510	CPE520
Wireless Speed	2.4G 300Mbps	2.4G 300Mbps	5G 300Mbps	5G 300Mbps
Transmit Power	27dBm	30dBm	23dBm	27dBm
Antenna Gain	9dBi	12dBi	13dBi	16dBi
HPBW Angle	65°	60°	45°	45°
Interface	10/100Mbps Ethernet port *1	10/100Mbps Ethernet port *2	10/100Mbps Ethernet port *1	10/100Mbps Ethernet port *2
Power Supply	24V Passive PoE	24V Passive PoE	24V Passive PoE	24V Passive PoE
Recommended Distance	3km	8km	15km	20km

WBS is another access point device and works together with external antennas (2*2 MIMO Antenna). So far we have two models of WBS: WBS210 and WBS520. The specifications are as follows:

Model	WBS210	WBS520
Wireless Speed	2.4GHz 300Mbps	5GHz 300Mbps
Transmit Power	27dBm	27dBm
Interface	2*10/100Mbps Ethernet Port 2*RP-SMA Male	2*10/100Mbps Ethernet Port 2*RP-SMA Male
Power Supply	24V Passive PoE	24V Passive PoE

Recommended Distance	Dish Antenna: 30km Sector Antenna: 5km Omni Antenna: 2km	Dish Antenna: 40km Sector Antenna: 15km
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Pharos MIMO Antenna include three types of antenna: Sector Antenna, Dish Antenna and Omni Antenna. They are able to provide wireless coverage for different scenarios and requirements. So far we have five models of MIMO Antennas: TL-ANT2424MD, TL-ANT2415MS, TL-2410MO, TL-5830MD and TL-ANT5819MS. The specifications are as follows:

Model	TL-ANT2424MD	TL-ANT2415MS	TL-ANT2410MO	TL-ANT5830MD	TL-ANT5819MS
Type	Dish	Sector	Omni-directional	Dish	Sector
Frequency	2.4GHz	2.4GHz	2.4GHz	5GHz	5GHz
Gain	24dBi	15dBi	10dBi	30dBi	19dBi
HPBW Angle	<5°	120°(6dB) 90°(3dB)	360°	<5°	120°(6dB) 90°(3dB)
Interface	2*RP-SMA Female	2*RP-SMA Female	2*RP-SMA Female	2*RP-SMA Female	2*RP-SMA Female
Scenario	P2P	P2MP	Hotspot	P2P	P2MP

3. Network Deployment and Configuration Guide: Product Selection

Pharos contains a variety of models that can work together flexibly. Therefore, you should deploy products for your wireless network depending on your requirements. We recommend the following solutions for WISP networks:

- **Backhaul** connection must take into consideration distance and bandwidth requirements. Based on our own experience with WISP customers, we recommended the following solutions based on WBS + Dish Antenna:

Product	WBS210+TL-ANT2424MD	WBS510+TL-ANT5830MD
Frequency	2.4GHz	5GHz
Distance	30km	40km
Throughput	30-60Mbps	30-50Mbps

Please note that this throughput data is for reference only and was gathered during testing at the recommended distance. The wireless performance in your own network environment may differ.

- **Access** connection must take into consideration the distribution of clients including the distance and angle from the antenna. The specifications of the solutions are as follows:

Solution	Enhanced				Economic	
AP side	WBS210+TL-ANT2415MS		WBS510+TL-ANT5819MS		CPE210/220	CPE510/520
Frequency	2.4GHz		5GHz		2.4GHz	5GHz
Angle	120°(6dB)& 90°(3dB)		120°(6dB)& 90°(3dB)		<65°	<45°
Client side	CPE210	CPE220	CPE510	CPE520	CPE210/220	CPE510/520
Distance	3km	5km	10km	15km	<3/5km	<10/15km

Note: the wireless throughput performance may be decreased since CE/FCC regulations limit wireless transmission power in outdoor areas.

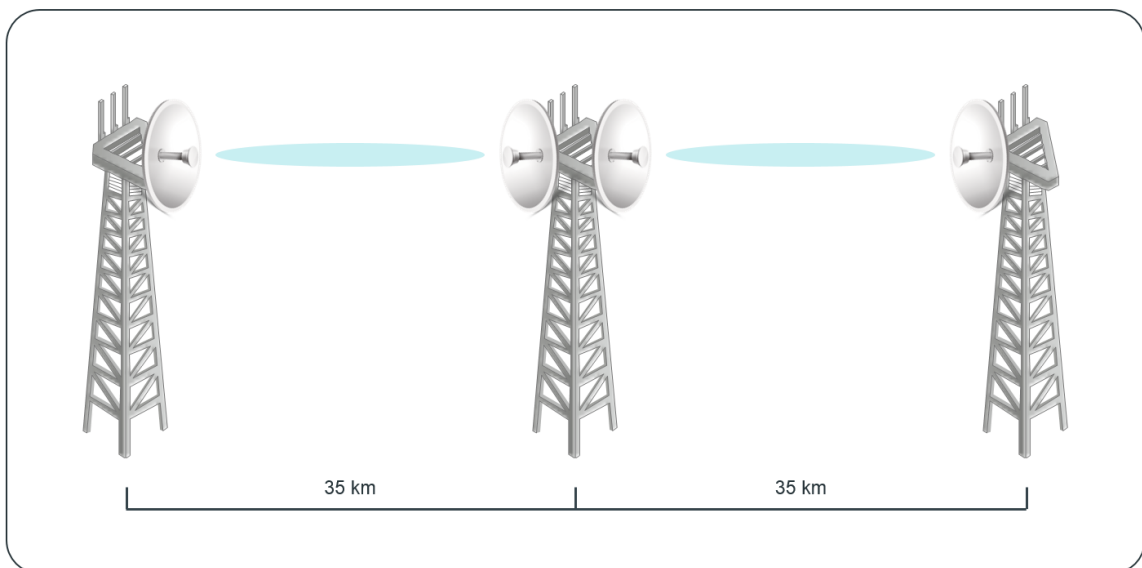
Generally, outdoor Wi-Fi networking cases for P2MP require a Base Station AP that has a wide range of wireless coverage. It is therefore recommended to adopt a solution based on WBS + Sector Antenna as a Base Station AP (Enhanced) and CPEs as the Client APs at the users' side. If there are few clients concentrated in a small area, you can also deploy a CPE product as a Base Station AP. A detailed description of that solution is not provided here.

- When deploying **Access** wireless networks, we need to select the quantity of Pharos APs. Generally, the number of Client APs (CPEs) is directly determined by the number of sub-sites, which means that you need to install Client APs at every sub site. For the Base Station, you need to investigate the capacity to load clients (how many WBS products are needed to load all clients) and distribution (how many WBS products you need to provide wireless coverage for all clients).

From our experience, a WBS with the MAXstream function off can load up to 20 CPEs. With MAXstream on, a WBS is recommended to load up to 50 CPEs. WBS + Sector Antenna can cover an area of 120°. Under special circumstances, if the client APs are very highly-concentrated, a single WBS does not have the capacity to load them. In this case, you need to deploy another WBS that covers the same range.

Is it possible to cover a distance of over 40km if a pair of WBS + Dish Antenna only cover a limited distance?

For this situation, we can try to add in a relay station to achieve an extra-long distance wireless connection. You could deploy multiple pairs of WBS + Dish Antennas for a wireless cascade and multiple Backhaul to expand the wireless connection distances. For instance, to cover 70km, you should deploy two pairs of WBS510 + TL-ANT5830MD products:



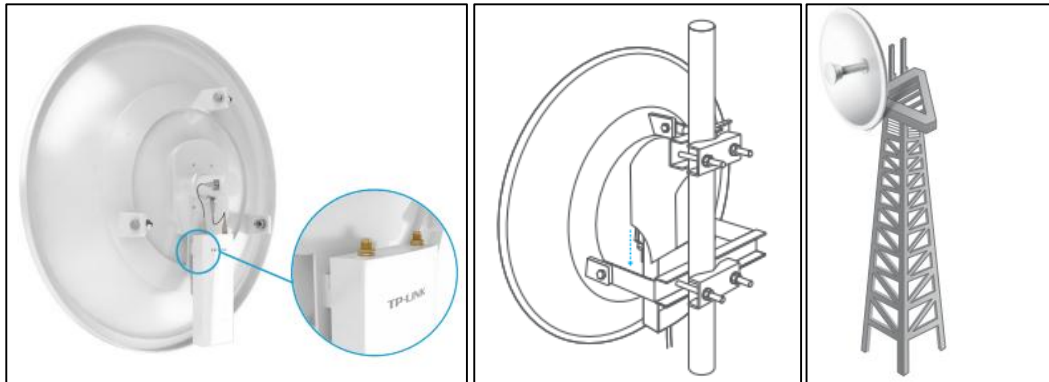
4. Network Deployment and Configuration Guide 4: Field Deployment

- **Field Deployment 1: AP Deployment.**

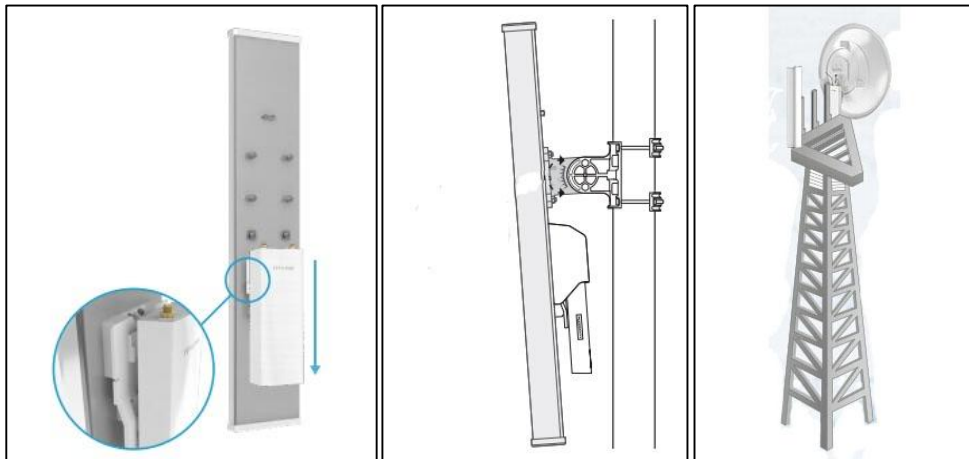
Note: Before installation, you should ensure the first Fresnel area between the installation sites is clear. If there are obstacles present that cannot be removed, you can increase your installation height to avoid them. For detailed information, please refer to [FAQ-907](#).

For the **Backhaul** network, we deploy a pair of WBS + Dish Antennas as P2P wireless links. Generally, WBS products are installed using a special bracket or signal tower due to the large size of the Dish

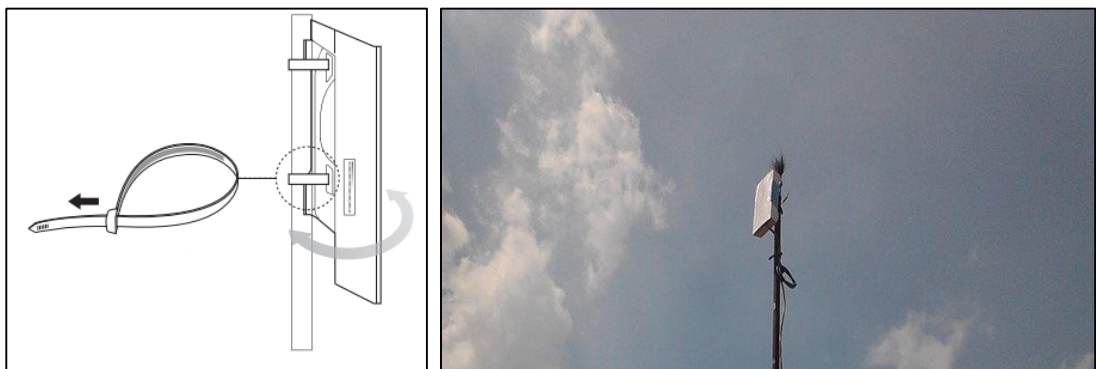
Antenna. Pharos Dish Antenna are designed with a dedicated slot to fix WBS to them. The antenna can be fixed to the signal tower with a metal bracket. For detailed information, please refer to the [TL-ANT5830MD Installation Guide](#).



On the **Access** (serving clients) side, we deploy another pair of WBS + Sector Antenna as the Base Station AP, with the installation identical to the WBS setup for the Backhaul network.

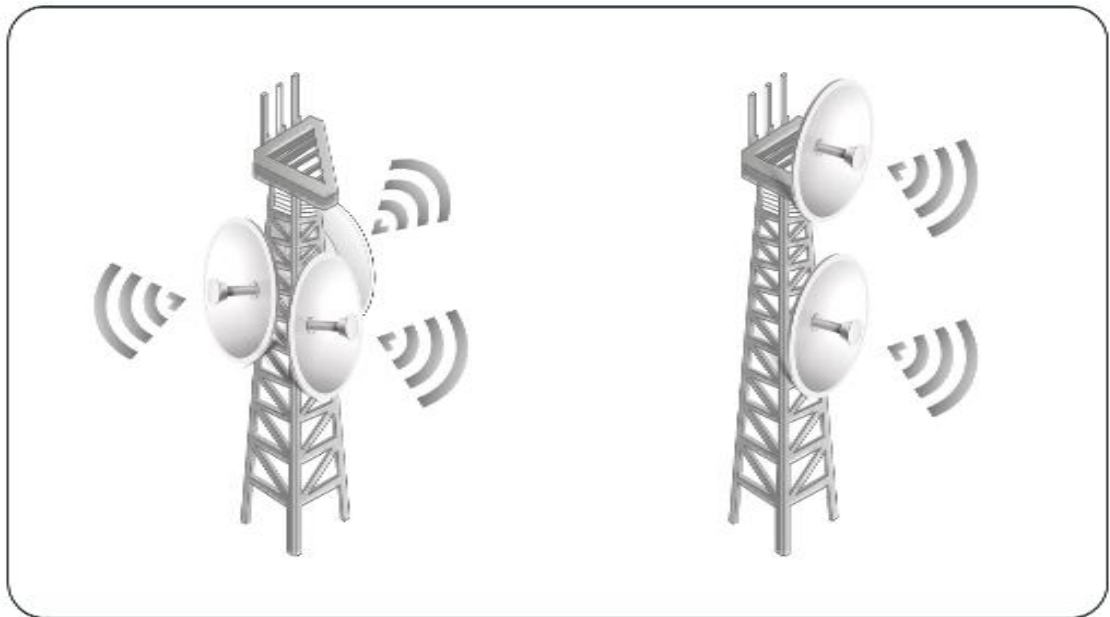


To provide internet access for users, we deploy CPEs as the client AP. Generally, they are pole-mounted, since users don't own a dedicated signal tower. The CPEs are designed with a binding slot, and the product comes with a special cable to fix it in place.



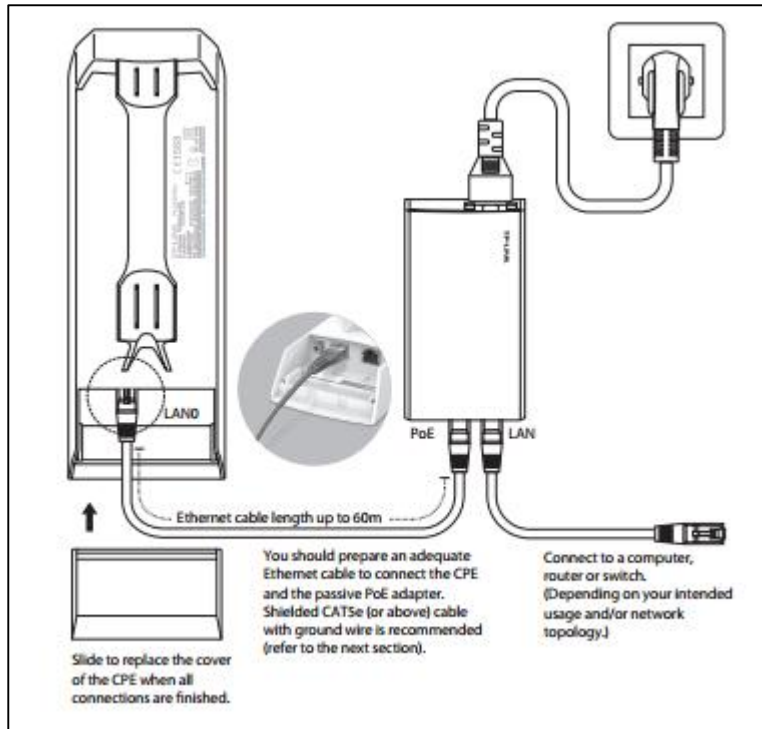
How can I avoid collocation interference when deploying multiple APs at the same site?

If you deploy multiple WBS products to provide wireless coverage in different directions, you could deploy them at different horizontal positions at the same height (as the left picture below shows); if you deploy multiple WBS products to provide wireless coverage in the same direction, you can deploy them with the same orientation but at different heights (as the right picture below shows). Please adjust the antenna's elevation angle too. **The latter case is for when there is a high number of Client APs concentrated in one direction and a single AP is unable to serve them. Thus, you need to deploy multiple Base Station APs to share the load.**



- **Field Deployment 2: Power Supply and Lightning Protection**

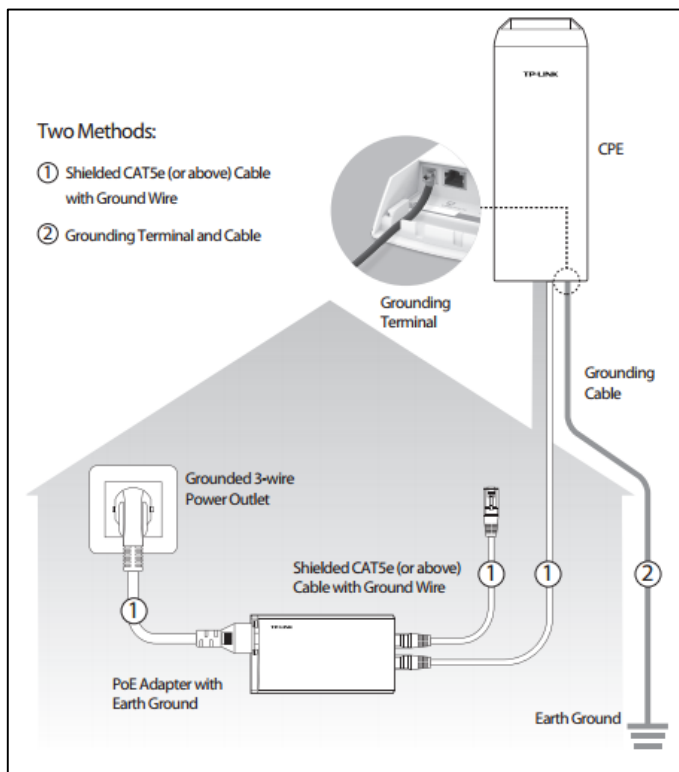
Pharos CPE/WBS products support 24V/1A Passive PoE power supply. The maximum distance from the power supply is 60m. Therefore, you can power the device with an indoor electric source.



Please note that Passive PoE is different to Standard PoE. You CANNOT supply power to CPE/WBS with PoE switches. For detailed information about PoE power supply, please refer to [FAQ-906](#).

If your project requires lightning protection:

- 1) Connect the ground electrode to the grounding terminal.
- 2) Use Cat5e (or above) Shielded twisted pair cables to work with the PoE Adapter (comes with product) for lightning protection.



- **Field Deployment 3: AP Configuration and Channel Optimization**

Backhaul networks deploy a pair of WBS + Dish Antennas as a P2P wireless link. You should log in to the management Web UI and configure one in AP mode and another in Client mode. For details, please refer to [FAQ-730](#) and [FAQ-727](#).

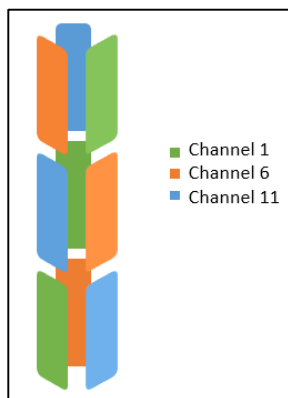
For the access point side, WBS + Sector Antennas and multiple CPE are deployed as a P2MP wireless link. You should configure the Base Station AP (WBS + Sector Antenna) in AP mode. Note that the Distance option should be set to 1.1 times of **the distance of the farthest client**. For further configuration details, please refer to [FAQ-730](#).

Client APs (CPEs) should be configured in Client mode and then connected to the Base Station AP. Note that the Distance option should be set to 1.1 time of the distance of Base Station AP. For further configuration details, please refer to [FAQ-727](#).

When configuring the client CPEs, you should choose a clean channel to help improve the throughput. Therefore, it is recommended that you perform spectrum analysis with the Spectrum Analysis tool in the web UI. You can then select a relatively clean channel manually.

How to avoid collocation interference when you configure channel optimization?

Sometimes, you may need to deploy multiple Base Station APs in the same signal tower, to cover multiple directions, or to connect to multiple Client APs. In such cases, the APs sharing the same signal tower may wirelessly interfere with one another (collocation interference). Therefore, it is recommended to configure adjacent APs in non-overlapping channels. Taking WBS210 as an example, if we need omnidirectional coverage, and three APs in each direction to serve multiple clients, you can refer to the following picture for deployment and channel planning.



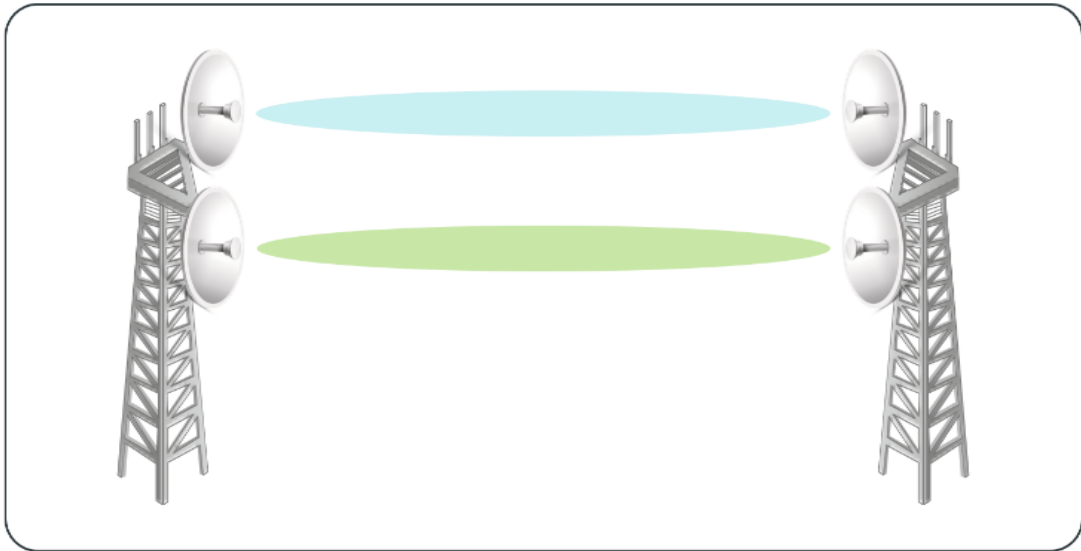
- **Field Deployment 4: Antenna Alignment**

In the network topology for P2MP, Base Station APs generally work with Sector Antennas, covering a large area. Thus, the Antenna Alignment tends to be simpler than for P2P networks. For detailed information, please refer to [FAQ-1044](#).

- **Field Deployment 5: Wireless Performance Testing and Optimization**

Bandwidth testing (wireless throughput test) also includes two parts: Backhaul and Access. You should test the wireless throughput with the Speed Test tool in the Pharos web management UI. For a detailed testing method, please refer to the [Pharos User Guide](#) pages 97-98.

If the Backhaul test results don't satisfy your requirements, you should deploy another pair of WBS products to improve the wireless throughput. Note that you need to configure Port Isolation or Link Aggregation on switches on both sides.



Another possible problem is that the WBS products at the access point side is overloaded or the channel capacity is insufficient. You could try deploying multiple WBS products and allocating clients by staggering the working channel of each base station to alleviate such problems.

c. Wireless Network Optimization

1. Wireless Network Optimization 1: Enable MAXream to Improve Wireless Throughput

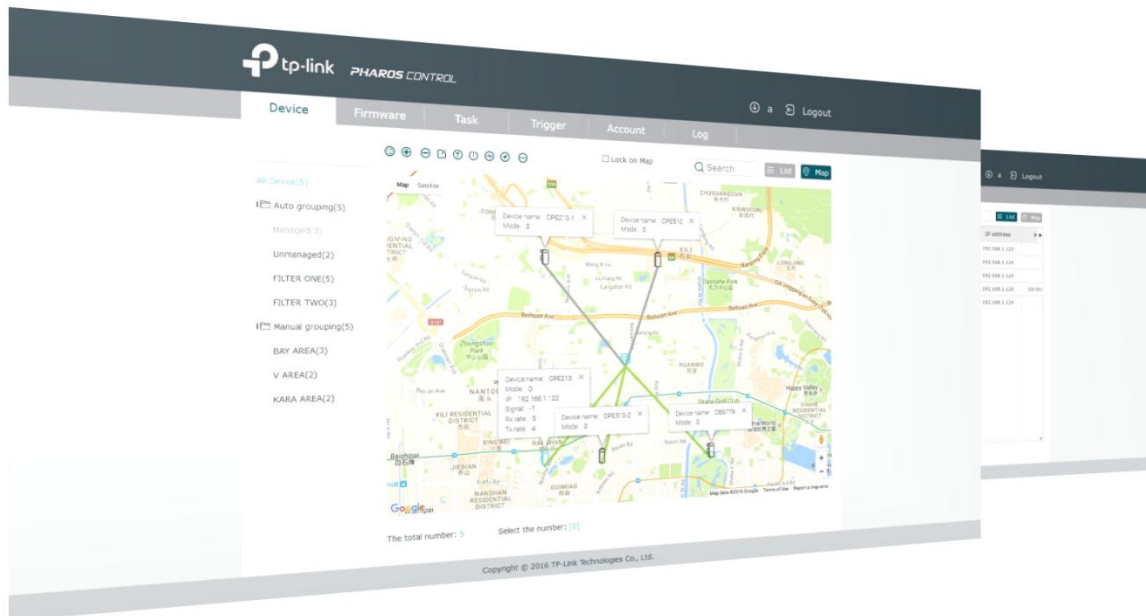
Traditional 802.11 WLAN is based on the CSMA protocol. As the number of clients increase in the outdoor network topology for P2MP, the probability of wireless conflicts will gradually increase, which results in a reduction in wireless throughput. The MAXream function can help to resolve this issue on Pharos APs, helping to improve wireless throughput for P2MP solutions.

With MAXream enabled, the Base Station AP will allocate timeslots to each client. Clients can then only transmit data in the timeslot allocated, meaning they no longer have to compete for the right to use the channel. In this way, wireless client conflicts are eliminated and the wireless throughput increased. For detailed information, please refer to [FAQ-694](#).

Although the benefits of MAXream for P2P networks are not so obvious, it is still recommended to enable MAXream so as to ensure network security. MAXream is a proprietary communication protocol developed by TP-Link, and is only compatible with Pharos series products. After deployment, only Pharos CPE/WBS products can join the network, which effectively prevents strangers with rogue equipment from accessing the network.

2. Wireless Network Optimization 2: Centralized Management and Maintenance with Pharos Control

For network management, the Pharos Control software allows centralized management and maintenance via an intuitive interface. With the help of Pharos Control, you can monitor the operating status and data traffic in real time, and perform common operations such as auto-upgrade, periodic reboot, exception notification and more.



3. Wireless Network Optimization 3: Enable Test Mode to Improve Wireless Throughput

Pharos series software includes Test Mode, which allows the access point to use higher transmission power and cleaner channels so as to avoid wireless interference and improve network performance.

IMPORTANT: Enabling Test Mode may violate local regulations regarding the transmission of radio waves in your country. Please ensure your product complies with local regulations in Test Mode before enabling it. The transmission statistics of Pharos products when operating in Test Mode are shown below.

Model	Frequency	Maximum Transmit Power	Antenna Gain
WBS210	2312-2572 MHz	27dBm/500mW	/
WBS 510	4920-6100 MHz	27dBm/500mW	/
CPE210	2312-2572 MHz	27dBm/500mW	9dBi
CPE220	2312-2572 MHz	30dBm/1000mW	12dBi
CPE510	4920-6100 MHz	23dBm/200mW	13dBi
CPE520	4920-6100 MHz	27dBm/500mW	16dBi

4. Wireless Network Optimization 4: Enable External Radius Server to Authentication & Accounting

If you are a WISP, WPA-Enterprise encryption with external radius server can be enabled when you configure your Base Station to improve the security of the wireless network.