

SkyPilot® Broadband Wireless Mesh Network Solutions



Changing the Economics of Wireless Broadband Connectivity

Broadband connectivity has become an essential utility to individuals and communities, yet many small communities and rural areas still have limited access to these services. Local governments and public safety agencies cannot justify dedicated deployments of wireless infrastructure equipment due to high costs. Today, however, the innovative SkyPilot network solution from Trilliant can change the economics for delivering affordable wireless broadband connectivity. Based on patented wireless mesh technology, the SkyPilot network solution allows service providers, public service agencies, and municipalities to cost-effectively deploy wireless broadband data, Wi-Fi, video surveillance, and voice-over-IP (VoIP) applications. A SkyPilot network offers tremendous flexibility and a manageable deployment approach by utilizing a minimal footprint and taking advantage of existing municipal assets such as building rooftops or streetlight poles to reduce deployment costs. No other wireless mesh solution can support the range of applications in demand by municipalities and service providers today with this combination of affordability and flexibility.

Rapid Deployment and High Scalability

A SkyPilot network deployment can deliver broadband coverage quickly by eliminating the need to negotiate for the use of leased lines or the time required to install cabling and other wired infrastructure needs. Additionally, the SkyPilot network's use of mesh networking allows network coverage

to be expanded beyond each node's radio range, avoiding buildings, terrain, and other obstacles so that connectivity can be deployed exactly where it is needed. Simply install a SkyPilot device and it automatically discovers the network and self-configures, using dynamic best-path routing to become a node of the resilient multi-hop SkyPilot mesh network. These features allow a SkyPilot network to be deployed rapidly with high scalability.

Reduced Operating Expenses

The innovative technology advantages provided by a SkyPilot high-performance wireless mesh network help reduce management and operating expenses and can give the network operator a rapid return on investment. Automatic discovery, self-provisioning, dynamic antenna switching, automatic antenna alignment and intelligent routing features eliminate the need for specialized expertise and costly provisioning or management systems. Thanks to these and other features, a network operator using SkyPilot technology can easily, securely, and cost-effectively scale the deployment, support different groups of subscribers, and deliver multiple diverse applications.



SkyPilot® Wireless Mesh Networks Offer Scalability and Performance

The flexible and scalable SkyPilot network technology can support concurrent data, voice, and video applications, mixed-use networks, and multiple tiers of service. Using a unique synchronous protocol and advanced beamswitching antenna arrays, SkyPilot solutions enable unmatched scalability and performance for all broadband wireless applications.

SkyPilot Wireless Mesh Architecture

The SkyPilot wireless mesh architecture is specifically designed to maximize packet throughput, enable Quality of Service (QoS), and deliver high scalability while preserving the resiliency and flexibility of wireless mesh communications. Based on an innovative and unique protocol, the SkyPilot wireless mesh architecture automatically manages multiple wireless mesh operations that would otherwise require specialized personnel or complex management systems.

Automatic Link Discovery

Active SkyPilot nodes automatically detect the presence of new neighboring mesh nodes and fixed-wireless customer premise equipment (CPE). Once a node is located, it is first authenticated to join the network and then all links to the node are encrypted using a 128-bit AES cipher. Network administrators can centralize and automate delivery of configuration files and IP addresses, making it easy to add mesh nodes and expand network coverage as needed.

Mesh Route Optimization

Traffic is routed between SkyPilot wireless mesh nodes by using a dynamic best-path, vector-based routing algorithm to form a resilient multi-hop mesh network. If a primary network link experiences a sustained reduction in throughput, then the next lowest-cost secondary link is automatically converted to the primary status. Additionally, in the unlikely event of a sudden and complete network outage, SkyPilot nodes employ a self-healing failover mechanism to automatically route around the point of failure. With route calculation and best-path selection operating continuously in real-time throughout the network, a SkyPilot network deployment automatically balances capacity and adapts to any changes in link quality or the failure of any SkyPilot mesh node.

Traffic Management

Customizable packet analysis rules enable the SkyPilot network operator to prioritize, shape, and filter traffic on a per-subscriber and per-application basis, as well as, create customized Virtual LANs (VLANs) for traffic segmentation and separation on a per-user basis. SkyPilot

wireless mesh protocol traffic management features support multiple tiers of services, groups of users, and enhanced security strategies.

Bandwidth Scheduling

A bandwidth scheduling engine enables traffic prioritization and determinism at each node to minimize latency and jitter, achieve guaranteed QoS, and maximize throughput. This technique ensures that high-priority traffic, such as public safety or VoIP communications, takes precedence over lower priority traffic.

Transmission Coordination

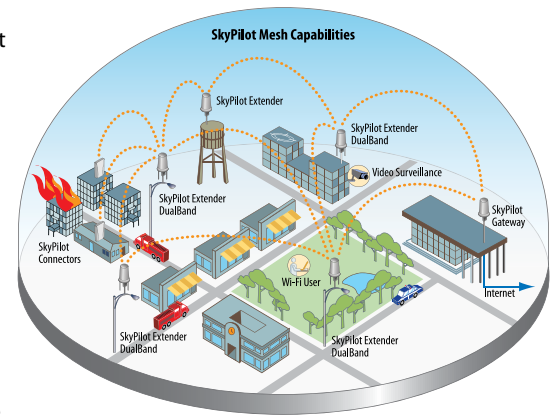
The SkyPilot wireless mesh technology uses a Time-Division Duplex (TDD) protocol to synchronize all node transmissions and a Global Positioning System (GPS)-based common clock to coordinate simultaneous transmissions across the entire mesh network. The combination of these techniques helps maximize throughput, minimize latency, and reduce interference throughout a SkyPilot network.

SkyPilot Advanced Antenna Array

SkyPilot infrastructure equipment incorporate a sophisticated beamswitching antenna array composed of eight directional antennas and supported by a single radio. Instantaneously, only a single antenna is in use, with beamswitching at up to 10,000 times per second coordinated across the network to establish links with other neighboring devices. Because of this unique beamswitching operation, the SkyPilot technology qualifies under FCC and other regulatory point-to-point rules to use its high-gain antennas and operate with high transmit power in the 5 GHz band without requiring a license.

High Gain & Transmit Power

Each directional antenna provides 18 dBi gain with a 45° azimuth and 6° elevation beamwidth, where this relatively narrow beamwidth helps to mitigate interference and facilitate spectral reuse. The SkyPilot equipment is then configured to operate at the maximum transmit power levels allowed by the regulations that are applicable in the country of operation. With the combination of high gain and high transmit power,



node-to-node range of as much as 10 miles/16 kilometers can be achieved, depending upon local conditions.

Sectorization & Adaptive Modulation

The array of eight directional antennas provides 360° of coverage, with each antenna effectively supporting an independent sector. The SkyPilot radio employs Orthogonal Frequency-Division Multiplexing (OFDM) with 52 digitally modulated subcarriers, where the SkyPilot mesh protocol enables communicating SkyPilot nodes to dynamically and adaptively change the modulation type of the OFDM subcarriers and their Forward Error Correction (FEC) code rate based on the current conditions of the link, thereby changing the air data rate. Air data rates then range from 6 Mbps for the worst link conditions to as much as 54 Mbps for the best links, thereby supporting a wide range of challenging propagation environments due to obstructions, foliage, non-line-of-sight multipath, and interference.

Embedded Security Features

Wireless network system security is a major concern for all broadband wireless mesh networks, but especially for public safety agency and government applications. In a SkyPilot network deployment, wireless mesh nodes are authenticated using certificate-based mesh authentication. Once a node is authenticated and is part of the SkyPilot network, all links to it are then encrypted using a 128-bit AES cipher. Additionally, Wi-Fi subscriber connections can be secured using a variety of techniques, including WPA/WPA2, EAP authentication types, and support for RADIUS authentication.

SkyPilot® Wireless Mesh Network Products

The SkyPilot wireless mesh network is a low-latency, high-bandwidth radio system operating in the 5 GHz bands as a self-forming, self-balancing, and self-healing wireless mesh network. The intelligent, self-forming SkyPilot mesh technology manages traffic across the mesh network to mitigate interference, maximize available bandwidth, and support the prioritization of voice and data for improved Quality of Service performance. The SkyPilot network provides a range of services for fixed broadband access subscribers, roaming Wi-Fi users, public safety professionals, mobile municipal staff, and public works agencies.

SkyPilot Gateway Series

SkyPilot Gateway products are carrier-class network base stations that serve as network takeout points and root nodes of the SkyPilot network.

Each SkyPilot Gateway controls a subnetwork of associated SkyPilot Extenders and Connectors to provide coverage and capacity as needed. By deploying additional SkyPilot Gateways, a service provider can "inject" capacity into the network, extend network coverage, and enhance network reliability. Unlike a conventional point-to-multipoint base station, the SkyPilot Gateway is the foundation of a true mesh topology that delivers multi-hop versatility, dynamic re-routing in the event of node failure, and outstanding scalability.



SkyPilot Gateways and Extenders are also available in DualBand models. These models are available with integrated access points that allow for simultaneous wireless access to the SkyPilot wireless mesh network, using the 2.4 GHz band for public Wi-Fi connectivity.

SkyPilot Connector Series



SkyPilot Connector products are CPE endpoints of the SkyPilot network. Each Connector provides client devices with a wired Ethernet connection to the broadband Layer 2 Ethernet transport supported by the SkyPilot wireless mesh

network. In this way, the Connector offers its users reliable and cost-effective broadband wireless access to support TCP/IP and other traffic.

The SkyPilot Connector DualBand is a versatile dual-radio/dual-frequency CPE endpoint of the SkyPilot network that integrates a high-capacity wireless 5 GHz backhaul radio supporting air data rates of up to 54 Mbps and a Wi-Fi local access 2.4 GHz radio into a single device. This combination offers two simultaneous ways to access the broadband Layer 2 Ethernet transport provided by the SkyPilot network, either through a wired Ethernet connection to the Connector DualBand or through a wireless Wi-Fi connection to the Connector DualBand.

SkyPilot Connector products can be configured to operate in a variety of different 5 GHz bands for a wide range of international deployments, with each unit using a high-gain integrated panel antenna to provide directional coverage to other SkyPilot mesh nodes.

SkyPilot Connector products have been designed to be quickly and simply deployed. Each Connector's audible and visual cues help in aligning its integrated panel antenna toward nearby SkyPilot Extenders or Gateways. The Connector's auto-discovery and auto-provisioning features then ensure proper installation in the network and minimize both deployment and ongoing operational costs.

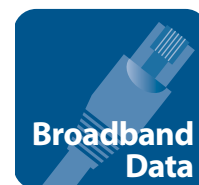
SkyPilot Element Management System (EMS)

The SkyPilot Element Management System (EMS) provides SNMP-based network element management capabilities. The SkyPilot EMS manages SkyPilot network devices, providing control and monitoring capabilities over the network's physical and logical connectivity, implementing a Fault, Configuration, Performance, and Security (FCPS) network management administration model for the SkyPilot wireless mesh network. The SkyPilot EMS integrates with the Google Earth plug-in service to enhance the preparation and maintenance of SkyPilot network diagrams while providing automatic and dynamic network visualization. The SkyPilot EMS automatically discovers and obtains topology information and provides complete fault management, performance tuning and monitoring, reporting, and alarm capabilities for a service provider managing a complex territory-wide SkyPilot network. These essential features, coupled with the fundamental mesh technology of the SkyPilot network, can help the service provider maximize subscriber satisfaction while sustaining a profitable business model.

SkyPilot Extender Series

SkyPilot Extender products are elements of the SkyPilot network that act as a relay node of the SkyPilot network and provides Ethernet connectivity for client devices. As a relay node, each Extender dynamically routes packets to other nodes of the SkyPilot network. Mesh networking then allows coverage to be extended beyond each node's radio range, avoiding buildings, terrain, and other obstacles to

deploy SkyPilot connectivity exactly where it is needed. Route diversity provided by the mesh acts as a failover mechanism in the event that a SkyPilot node fails or a link's quality degrades. Adding more Extenders readily expands the coverage of the SkyPilot mesh network -- simply install an additional Extender and it automatically discovers the network and self-configures, using dynamic best-path routing to become a node of the resilient multi-hop SkyPilot mesh network.



SkyPilot® Product Specifications



	SkyPilot Gateway Series	SkyPilot Extender Series	SkyPilot Connector Series
Models	<ul style="list-style-type: none"> SkyPilot Gateway SkyPilot Gateway DualBand 	<ul style="list-style-type: none"> SkyPilot Extender SkyPilot Extender DualBand 	<ul style="list-style-type: none"> SkyPilot Connector SkyPilot Connector DualBand SkyPilot Connector Mini SkyPilot Connector Pro
Function	<ul style="list-style-type: none"> Network takeout point Capacity injection 	<ul style="list-style-type: none"> Mesh relay node Coverage expansion 	Customer Premise Equipment (CPE)
Connectivity	<ul style="list-style-type: none"> To/from SkyPilot Extenders and/or Connectors as a root node of the SkyPilot 5 GHz mesh network 10/100BaseT port to/from head end and as Power-over-Ethernet (PoE) power input RS-232 serial console port for maintenance Optional access point for 802.11b/g (2.4 GHz) 	<ul style="list-style-type: none"> To/from SkyPilot Gateways, Extenders, and/or Connectors as a relay node of the SkyPilot 5 GHz mesh network 10/100BaseT port to/from client device(s) and as Power-over-Ethernet (PoE) power input RS-232 serial console port for maintenance Optional access point for 802.11b/g (2.4 GHz) 	<ul style="list-style-type: none"> To/from SkyPilot Gateways and/or Extenders as an endpoint node of the SkyPilot 5 GHz mesh network 10/100BaseT port to/from client device(s) and as Power-over-Ethernet (PoE) power input 2.4 GHz 802.11b/g access point to/from wireless client devices (Connector DualBand only)
Installation	Mast, tower, utility pole, streetlight pole arm, or building (optional mounting kits available)		Pole- or panel-mounted (eave, rooftop, chimney, etc.)
Enclosure	NEMA Type 4X / IP66		<ul style="list-style-type: none"> Outdoor UV-stabilized plastic IP65 Tamper proof seal/locking mechanism

5 GHz Mesh Backhaul

Frequencies	4.940 to 6.075 GHz, including: <ul style="list-style-type: none"> US: 4.940 - 4.990 GHz US: 5.250 - 5.350 GHz US: 5.470 - 5.725 GHz US: 5.725 - 5.850 GHz World: 5.850 - 6.075 GHz 	4.940 to 6.075 GHz, including: <ul style="list-style-type: none"> US: 4.940 - 4.990 GHz (Connector & Connector DualBand only) US: 5.250 - 5.350 GHz US: 5.470 - 5.725 GHz US: 5.725 - 5.850 GHz World: 5.850 - 6.075 GHz
Throughput	<ul style="list-style-type: none"> Up to 20 Mbps (UDP) Up to 12 Mbps (TCP) 	
Modulation	OFDM with adaptive modulation	
Range	Up to 10 miles/16 kilometers	Up to 7.5 miles/12 kilometers
Security	<ul style="list-style-type: none"> AES-128 encryption Certificate-based authentication 	

Optional Wireless Access Point (DualBand Products only)

Frequencies	2.400 - 2.4835 GHz
Protocol	IEEE 802.11b/g (2.4 GHz)
Modulation	<ul style="list-style-type: none"> 802.11b: DSSS 802.11g: OFDM
Security	WPA, WPA2, multiple SSIDs, MAC address Access Control List, MAC address filter, 802.1x EAP-TLS, EAP-TTLS, RADIUS Support



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