



User Guide
Gateway (GW1050)
Seed/CPE (SD1050)

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1 Introduction

The SkyPilot Gateway (GW1050) and Seed/CPE (SD1050) provide a complete, high-performance wireless system operating in the unlicensed 4.9 GHz public safety band. The flexible and highly scalable SkyPilot system is ideally suited to a wide range of applications. The system offers:

- **High Capacity and Long Range**

OFDM technology, a large link budget and modulation rates of 6-54Mbps, provide reliable Non-LOS operation and market leading capacity.

- **Meshing**

The system offers the flexibility of customer connection directly to a SkyPilot Gateway (GW1050) or via an intermediary Seed (SD1050), resulting in vastly increased coverage when compared to typical point-to-multipoint systems.

- **Standards Based**

The SkyPilot system is based very closely on the 802.11 standard and utilizes commercial chipsets. SkyPilot has implemented significant enhancements that provide range and performance advantages.

- **Easy Installation**

The compact, environmentally hardened, fully integrated Gateway and Seed/CPE require minimal configuration and can easily be installed on a multitude of locations.

- **Networking**

The SkyPilot system implements an intelligent, Ethernet switching network, with a 10/100bT bridge interface provided by the Gateway and Seed/CPE. Subscriber rate control and traffic prioritization QoS mechanisms are supported, along with optional VLANs. In addition, there is support for configurable protocol filtering and Access Control Lists (ACL).

- **Security**

AES link encryption and complete node authentication with optional support for full MD5 certificates.

- **Network Management**

Both node types are fully manageable via SNMPv2c and a Command Line Interface (CLI). Static or DHCP IP address allocation is supported.

1.1 Gateway (GW1050)

The Gateway (GW1050) is a fully integrated, environmentally hardened device providing the interface between a wireless SkyPilot network and the Internet/Wide Area Network (WAN). The connection to the Internet is via a single 10/100bT Ethernet port. The connection to the SkyPilot Seed/CPE (SD1050/SC1050) units is via multiple, individually optimized wireless links.

The SkyPilot Gateway houses eight individual antenna elements providing a total of 360 degree horizontal coverage and a 12 degree vertical angle. These antennas, along with all RF and digital circuitry, are integrated in a compact, light-weight, environmentally hardened housing. Note that only one antenna is selected at any one moment in time.

1.2 Seed/CPE (SD1050)

The Seed/CPE (SD1050) provides for both the extension of a wireless network and the local connection for a subscriber. It may be deployed in any of the following modes:

- **Seed Only**

An SD1050 can be deployed solely for the purpose of expanding the wireless network. In this mode, a subscriber interface shall *not* be provided.

- **CPE Only**

An SC1050 can be deployed solely for the purpose of providing a subscriber interface to the wireless network. The unit is installed on (or close to) a subscriber's home or business and the 10/100bT Ethernet interface provides a high-speed network interface.

- **Combined Mode**

An SD1050 can provide a subscriber interface while *also* expanding the wireless network. A unit installed on a subscribers premise also provides for the expansion of the network with (typically) multiple wireless links to other units.

The SD1050 is mechanically and electrically identical to the GW1050, containing the same antenna array. A single 10/100bT Ethernet port provides a subscriber interface.

2 Network Architecture

The GW1050 and SD1050 combine to create a robust, high capacity wireless network. All links within the network are established and optimized automatically. A highly efficient routing algorithm selects the best path for user traffic and heals around any network failures.

2.1 *Link Establishment*

A Gateway is installed and configured for a given channel within the UNII band - see Section 4.1.1 for details of frequency selection and configuration. This Gateway will signal its presence through the use of a periodic beacon message transmitted on the configured frequency utilizing a single antenna. When a Seed/CPE is installed it listens for this network beacon message. When a beacon is received, the Seed/CPE shall respond and attempt to establishment a link.

Once a link is successfully created, the two units will automatically complete link optimization. This ensures the selection of optimal antenna, power setting and modulation rate. The SkyPilot units support modulation rates of 6-54Mbps and the highest, reliable rate shall be selected through the exchange of test packets. Note that established links are continually monitored and periodically optimized.

2.2 *Routing*

Once a Seed/CPE has connected to the network it shall select a route to the Gateway. The automatic route selection considers the number and modulation rate(s) of the constituent links. Once a route is selected, all user traffic shall be forwarded via this path.

Rerouting shall occur rapidly in the face of a link loss. Rerouting will also occur if a lower cost route is consistently available.

2.3 Bandwidth Allocation

The SkyPilot system implements a synchronization of the 802.11 protocol. This synchronization allows for the establishment of individual links between nodes utilizing a unique timing and antenna combination. In addition, highly accurate traffic rate and jitter control is enabled.

The SkyPilot system provides rate control for subscriber traffic both in the downstream (Gateway to CPE) and in the upstream (CPE to Gateway) direction. The maximum rate downstream and upstream rate can be specified for each subscriber. In conditions of over-subscription when the overall bandwidth demand is higher than the system capacity, the individual subscriber data rates will be reduced proportionately. i.e. a configured 2Mbps is reduced to 1.5Mbps while a configured 1Mbps rate is reduced to 750kbps.

See Section 4.2.4 for details of the subscriber rate configuration.

2.4 Networking

The SkyPilot system operates as a Layer 2 network. The GW1050 and SD1050 have an Ethernet bridge. All upstream subscriber traffic is direct out the GW1050 Ethernet port and to external switch or router.

The GW1050 and SD1050 implement a SNMPv2c agent. In addition, there is also a CLI that may be access locally via a serial port or remotely via Telnet. In order to support these interfaces, an IP address must be allocated. This allocation can be done dynamically via DHCP or may be statically configured. See Section 4 for details.

3 Installation

In a typical wide-area wireless network utilizing SkyPilot units, the Gateway is installed on the roof of a tall building or tower. The direct coverage area of the Gateway is generally proportionate to the height of the installation.

A Gateway may also be used in smaller scale networks. Examples include high-capacity business or academic campus interconnection, or a localized access network. In this case, the Gateway could be installed on a local, medium height building or utility pole.

As previously mentioned, the SD1050 may be deployed as a CPE, in which case it is installed on a customer location, or as a Seed device. As a Seed device it may be installed on medium height buildings, or utility poles.

3.1 Unit Mounting

A mounting bracket is provided with the GW1050 and SD1050 units. This bracket fastens to a standard 1.25inch diameter pole. Any mounting system that meets local wind-loading regulations and provides a 1.25inch diameter by 5inch long connecting surface will be satisfactory. The photograph below shows a typical rooftop unit installation.



3.2 Cabling

GW1050 and SD1050 both support Power over Ethernet (PoE) utilizing the Power Injector provided. *Note that the GW1050 and SD1050 units should be installed with the SkyPilot provided Power Injector only. The use of other PoE Power Injectors could result in damage to the unit.*

Both units provide a 10/100bT connector and an RJ45 serial interface. The 10/100bT Ethernet port provides interconnectivity for user and network traffic, while the serial port is used for local access to the CLI. The photograph below shows the Ethernet port on the right and the serial port to the left.



In order to ensure full weatherproofing, the grommet provided must be installed. The Ethernet cable should first be connected and then pushed into the slit in the gasket and then the gasket is pushed into the opening in the base. See the photograph below.



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Finally the cover is installed using the provided screws. The Ethernet cable is position to pass through the insert in the cover. It is highly recommended that the cover and gasket be fitted in a Seed Only application (i.e. no subscriber or WAN interface).



Once the node is installed, it is recommended that the Ethernet cable be secured to prevent strain (particularly installations exposed to high wind conditions). The photograph below shows an example where the cable is secured to the mounting pole.



4 Configuration

The SkyPilot system requires minimal configuration before service can be offered. There is the option to utilize the SkyPilot Provisioning Server or to manual configure. The Provisioning Server, with its interface to an SQL database facilitates the configuration of large scale networks. The Provisioning Server is the topic of a separate document. This document shall focus on the manual configuration of GW1050 and SD1050 units.

4.1 GW1050 Configuration

The Gateway must be configured for the following:

1. Frequency
2. IP Address Mode – DHCP or Manual
3. Management IP Address and Mask (if manually configure)
4. Ethernet Port Control

4.1.1 Frequency

The Gateway supports operation in the public safety band of 4.94 to 4.99 GHz. With its directional antenna and large link budget, the SkyPilot system is very effective in avoiding interference. However, if there are situations where significant interference is present within the public safety band band. SkyPilot recommends that an operator utilize a spectrum analyzer to scan the frequency spectrum prior to installing one or more GW1050. If a high level of interference is observed, then a subset of the available channels should be selected.

4.1.2 IP Address Management

The Gateway management interface (SNMP, Telnet) requires the allocation of an IP address. A Gateway can be configured to use either DHCP for dynamic IP address allocation or can be statically configured via the CLI.

DHCP is the default. For static allocation the IP Address, Netmask and IP Default Gateway must be input via the CLI. See Section 5 for details.

4.1.3 Ethernet Port Control

The GW1050 allows for the disabling (and enabling) of the 10/100bT Ethernet port. Default is enabled. It is anticipated that the disabling of the Ethernet port may be used for troubleshooting purposes.

4.2 SD1050 Configuration

A SD1050 must be configured for the following:

1. IP Address Mode – DHCP or Manual
2. Management IP Address and Mask (if manually configure)
3. Ethernet Port Control
4. QoS Data Rates

4.2.1 IP Address Management

The SD1050 management interface (SNMP, Telnet) requires the allocation of an IP address. It can be configured to use either DHCP for dynamic IP address allocation or can be statically configured via the CLI.

DHCP is the default. For static allocation the IP Address, Netmask and IP Default Gateway must be input via the CLI. See Section 5 for details.

4.2.2 Ethernet Port Control

The SD1050 allows for the disabling (and enabling) of the 10/100bT Ethernet port. Default is disabled. The disabling of the Ethernet port is recommended in the case of Seed Only application (i.e. when there is no subscriber interface). The enable/disable Ethernet port facility can also be used to control subscriber access in the case of a CPE Only or Combined application.

4.2.3 Subscriber Data Rates

The SD1050 allows for configuration of maximum downstream and upstream data rates. These values are selected from a list of defined options. The values relate to traffic sent and received over the Ethernet port and are *not* applicable in the case of a Seed Only application.

5 CLI

The GW1050 and SD1050 both provide a complete CLI interface. This interface may be used to configure and monitor the unit. A full definition of the CLI is available – email support@skypilot.com to request a copy.

As an example, the GW1050 configuration screen is shown below. All other GW1050 parameters are read-only.

```

Tera Term - COM1 VT
File Edit Setup Control Window Help

> set ?
eth      - Activate or disable Ethernet port.
          Synopsis: set eth <up | down>

freq     - Set the radio frequency.
          Synopsis: set freq <5745 | 5765 | 5785 | 5805>

defaultgw - Set the IP address of the default gateway.
          Synopsis: set defaultgw <IP address>

ip       - Set the Ethernet IP address.
          Synopsis: set ip <IP address>

mask     - Set the netmask.
          Synopsis: set mask <netmask>

> set ip 192.168.4.189
> set defaultgw 192.168.4.1
> set mask 24
> set freq 5785
> set eth up
> show flash
IP Address = 192.168.4.189
Net mask = 24
Default route = 192.168.4.1
Frequency = 5785
Node type = Mesh Gateway
Ethernet state = up
> █
    
```

6 SNMP

Both GW1050 and SD1050 have a SNMPv2c agent. The following MIBs are supported:

1. MIB-II (RFC 1213)
2. EtherLike (RFC 2665)
3. Bridge (RFC 1493)
4. SkyPilot Private MIB

Email support@skypilot.com to request a copy of the SkyPilot MIB.

7 FCC Radio Frequency Interference Statement

SkyGateWay/SkyExtender FCC Number: RV7-GW-SD1050

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 90 of the FCC Rules. These limits are designed to provide reasonable protection against interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed, and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:

This equipment has been certified to comply with the limits for a class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

Maximum Permissible Exposure

In order to meet the FCC's requirement of 1 mW/cm² for Maximum Permissible Exposure (MPE) at 4.9 GHz, the SkyGateway/SkyExtender units must be located a minimum of 20 cm (8 inches) from all persons. This distance is determined based upon the aforementioned 1 mW/cm² limit, measured data, and the far-field peak power density equation below:

$$d = \frac{0.282 \left[10^{((P+G)/20)} \right]}{\sqrt{S}}$$

where:

d = MPE distance in cm

P = Power in dBm (peak)

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm² (1 mW/cm²)

Certified laboratory measurements indicate that the FCC's Power Density Limit of 1 mW/cm² is met at a distance of much less than 20 cm (8 inches). However the minimum distance for fixed or mobile transmitters is 20 cm even if calculations indicate the MPE distance is much less.