Prioritization and Management of VoIP & RTP's

Introduction

This document will outline the process by which the SkyPilot network can be configured to optimize the performance of VoIP and other Real Time Protocols (RTP's). There are specific network and link conditions that directly contribute to the overall performance of VoIP. These essentials will be covered first. The discussion will then turn to configuration of QoS for the SkyPilot network that maximizes available timeslots and end with the configuration of classifiers – the criteria used to identify which packets get priority. In the SkyPilot network, it's a combination of rate limiting and prioritization that that allow VoIP and RTP performance to be at its best.

What Impacts VoIP or RTP Performance?

There are several conditions that need to be met in order to achieve the desired performance of VoIP and RTP's. If these conditions are not met the quality of VoIP, or other RTP's, may be impacted.

- **Link quality** from the customer premise to the SkyGateway. The link RSSI between all SkyExtenders should maintain a target RSSI of 25, or above. Modulation rates should remain static and should be at 36Mbps for best performance. The RSSI and modulation rate values for the SkyConnector links should be similar.

  Low RSSI values can mean increased susceptibility to interference generated by transmissions within the SkyPilot network (self-interference) or other terrestrial interference generated by other 5.8GHz devices in the area local to a given link. Inadequate link margins mean that one, or more, data packets may be lost during transmission resulting in drop-outs and poor VoIP and RTP performance.

- **Adequate bandwidth** must be available **on all links** from the SkyGateway to the SkyConnector. The devices experiencing the most impact are the first-hop SkyExtenders and the SkyGateway. If adequate bandwidth is not available, prioritization of VoIP or other RTP traffic will not realize sufficient gains in performance.

  There are two common issues that impact bandwidth availability on the SkyPilot network. The first has to do with unwanted traffic on the network. This traffic can be generated by users, or enter the network from the outside. Externally sourced traffic can be throttled via a packet shaping device.

  Another method used to ensure adequate bandwidth centers around assigning asymmetrical traffic rates for users. The typical ratio is for every 10 bits per second (bps) downstream, the customer is assigned 1bps upstream. A more symmetrical ratio of 5bps to 1bps will also yield good results but sacrifice twice as many upstream time slots per active customer.

- **End-to-End QoS should be managed** from the VoIP, or RTP, gateway/server all the way to the client CPE device. Once prioritized traffic exits the SkyGateway it must be prioritized by the network hardware between the SkyGateway and the VoIP Soft Switch or RTP server in the network. The same requirement may also apply to traffic exiting the SkyConnector at the customer premise.

- **Network latency must be managed**. Latency within the SkyPilot network is a function of available timeslots within a devices scheduler. The most heavily utilized devices, in the SkyPilot network, are the first-hop SkyExtenders and the SkyGateway servicing those SkyExtenders. The latency, to the end-user, can be monitored throughout the day using a ping graphing agent such as SmokePing. This application should be configured to use ping packets that are the **same size** as those used in the critical RTP applications. If the latency to the CPE device consistently exceeds the maximum jitter buffer size for the protocol being used, additional bandwidth must be added and/or network traffic must be additionally filtered/shaped to ensure adequate available bandwidth.

Implementing QoS Rates for Effective Bandwidth Management

The first configuration parameters to be addressed are QoS rates. QoS helps to maintain satisfactory throughput for every customer attached to the SkyPilot network. The SkyPilot network utilizes Time Division Duplex (TDD) for data transmission. TDD consists of a single data channel resource that is shared in time. There are 1250 available timeslots, each second, for utilization by the network.

Each active child node receives equal numbers of timeslots each scheduling period but not necessarily equal bandwidth (bandwidth to a child node is a function of the modulation rate to the node). When a child node is active both upstream and downstream, the scheduled timeslots will be alternated between transmission and reception of data. If the bandwidth, assigned to a SkyConnector, is asymmetrical (e.g. 1Mbps x 128Kbps) this alternation occurs less frequently, and more overall bandwidth is available to all users, as a result of the ability to use fewer timeslots for upstream transmission.

Downstream to Upstream Bandwidth

As noted above it is preferred that the bandwidth assigned to SkyConnectors be asymmetrical with the downstream rate greater than the upstream rate. Typical internet file transfers average a ratio of 50 downstream bytes received per upstream byte transmitted. **Bandwidth settings should typically be 10:1,** or 5:1 (maximum), downstream to upstream ratio. This provides more than adequate bandwidth to the subscriber for all file transfers. It also provides adequate upstream bandwidth for upstream transfers. It also limits a given customers the ability to host services on their network.

It is important to configure EVERY customer on the network with asymmetrical QoS rates in order to effectively manage bandwidth to all nodes within the SkyPilot network. Configuring just VoIP customers in this manner will result in other customers utilizing available timeslots, reducing the total number of opportunities available to critical VoIP customers.

When networks are servicing predominantly business customers, there is a stronger demand for more symmetrical traffic rates. In these situations bandwidth management in the distribution network, utilizing packet shapers or other bandwidth control mechanisms, becomes a priority. Symmetrical bandwidth configurations (e.g. 1Mbps x 1Mbps) will typically host fewer customers before experiencing jitter/latency beyond what can be tolerated by VoIP or other RTP flows.

When assigning bandwidth for VoIP or RTP customers these ratios may change to accommodate the added bandwidth requirements for VoIP or RTP connections. For a customer using a VoIP protocol that requires 64Kbps, the upstream rate would typically be configured to 1/10 or 1/5 the downstream value PLUS 64Kbps to accommodate the VoIP traffic. In the downstream direction, configured traffic rates are typically much higher, (512Kbps, 756Kbps, 1Mbps, 1.5Mbps, etc) and should not require any changes.

How Do I Know When I've Exceeded System Capacity to Handle VoIP or RTP?

The best way to determine if system capacity has been exceeded is to **watch the statistics on the VoIP gateway** or the RTP server. These devices report on the quality of connections with statistics such as buffer overrun, buffer errored seconds, underruns, jitter, packet loss, out-of-order packets, etc. This data represents the quality of the data flows between the client and the termination device. As these values increase it signals that the data path between the VoIP Soft Switch or RTP server, and the CPE device is being compromised.

Another indicator of this issue is displayed using the "*show link stats"* command on the SkyGateway, SkyExtender and SkyConnectors in question. **RED Drops** is the stat you're looking for. If this value increments every poll, queued data is being dropped by the device. This data could be internet traffic, VoIP or RTP traffic. RED stands for Random Early Discard and it is implemented in both the priority and the normal queues on all SkyPilot devices.

What Other Traffic Management Issues Should I Be Aware Of?

VoIP and other RTP streams usually present a flow rate to the interface that does not vary over time. Internet traffic, on the other hand, occurs in bursts of packets on an interface. There may be situations when a burst of internet traffic, for end-users, enters the SkyGateway. Depending on the number of users to be serviced by that burst, and their location in the SkyPilot network, it could cause a significant jitter of downstream VoIP or RTP data streams.

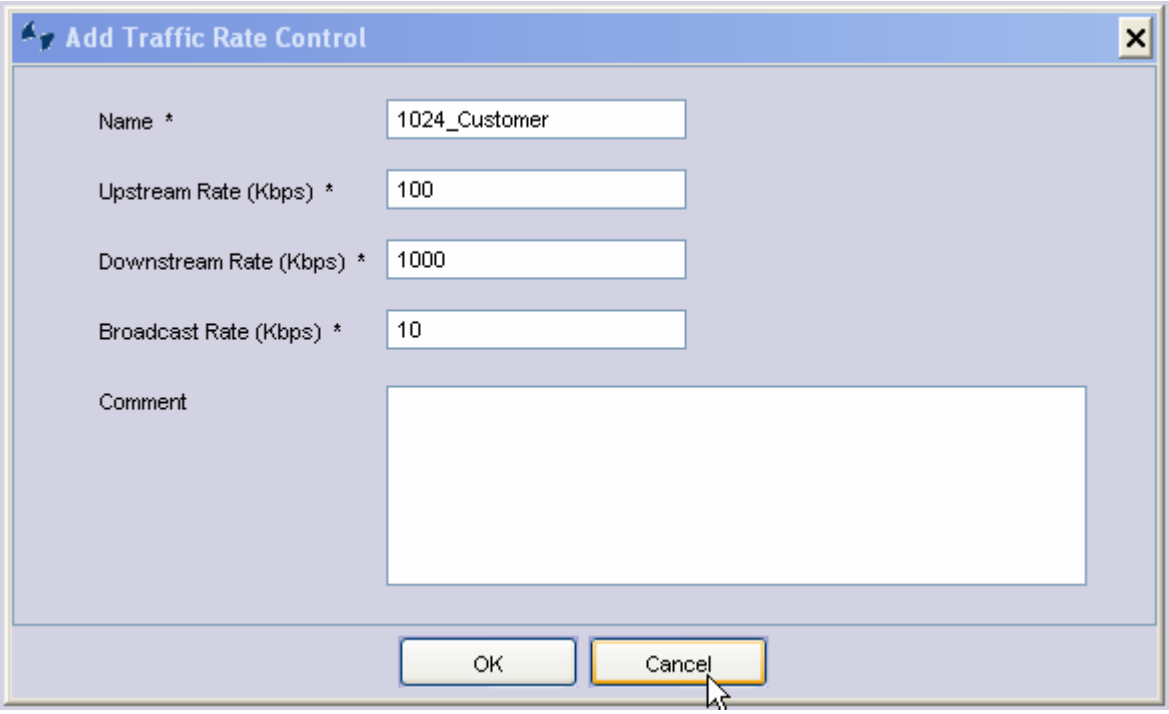
A traffic shaper can be utilized, prior to the SkyGateway, to **manage the packet burst rate to the SkyGateway**. This will reduce the otherwise significant variations in latency that might occur during periods of heavy bursts of traffic from the internet. This is more apparent when TCP Synchronization occurs as a result of queuing, or bandwidth issues between the client and the server.

The SkyGateway and SkyExtenders will portion out an equal number of timeslots for all active child nodes, during a scheduling interval. When the child node is scheduled the high-priority queue will be serviced first, and the normal priority queue will be serviced second. Child nodes with high priority data may not be serviced before child nodes with normal priority data. Scheduling is not based on priority; it's based on equal opportunity to all active child nodes. If a child node requires data transmission both upstream and downstream every other scheduled opportunity, for that child node, will be alternated between upstream and downstream.

Configuring QoS Bandwidth

This is a list of steps to be used to configure QoS Rates for individual SkyConnectors

- ☐ Click **SkyProvision**
- ☐ Click the "+" next to **QoS**.
- ☐ Click "**Traffic Rate Control**"
- ☐ Click "**ADD**"
- ☐ **Enter the values** for the specified QoS Rate(s) – example shown below.
- ☐ Click "**OK**"



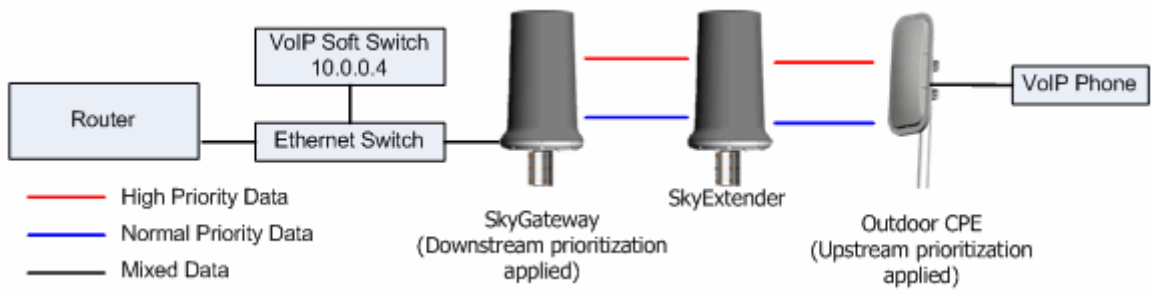
When configuring traffic rates for customers that will be utilizing both VoIP and Internet protocols at the same time, it is essential to **configure a QoS rate which will allow the VoIP flow and the Internet flow to occur simultaneously**. As an example, for a VoIP stream which requires 64Kbps, it might be advisable to configure an upstream rate of 128Kbps, 64Kbps for the priority VoIP traffic and 64Kbps for any internet traffic the user might generate during the VoIP phone call.

The Classifiers

The next step in the prioritization of VoIP and other RTP traffic is the configuration of classifiers. Classifiers are used to identify which fields, within an IP packet, are to be used to prioritize that packet for transmission to the SkyConnector or the SkyGateway. Classifiers are defined and then appended to the SkyConnector node profile. If the SkyConnector is in manual mode, classifiers can be configured through the SkyConnector CLI. The SkyConnector will forward the information, for traffic rates and classifiers, to the SkyGateway and its parent node during the registration process.

How to Determine Classifier Directionality

Classifiers can be configured as either upstream or downstream. In order to prioritize VoIP and other RTP protocols, both an upstream and a downstream classifier must be used. There are several ways that traffic can be classified and prioritized. We're going to discuss the most common method, utilization of the VoIP Gateway, or RTP server's IP address.



In the above example, the VoIP Soft Switch has an IP address of 10.0.0.4. When the VoIP Soft Switch sends traffic to a VoIP phone it will construct an IP packet with a Source IP Address of 10.0.0.4 (VoIP Soft Switch) and a Destination IP Address of the VoIP phone. Every packet sent by the VoIP Soft Switch to VoIP phones, on the SkyPilot network will have the same Source IP Address of 10.0.0.4 and different Destination IP Addresses.

When the VoIP phone, at the customer premise, sends data to the VoIP Soft Switch, it will construct an IP Packet with its unique Source IP Address. The Destination IP Address, in this packet, will be 10.0.0.4 – the IP Address of the VoIP Soft Switch. Every packet sent by a VoIP Phone, on the SkyPilot network, will have the same Destination IP Address – that of the VoIP Soft Switch.

The classifiers need to be configured in the following way:

Type of Classifier	Direction	IP Address	IP Mask
Source IP Address	Downstream	10.0.0.4	255.255.255.255
Destination IP Address	Upstream	10.0.0.4	255.255.255.255

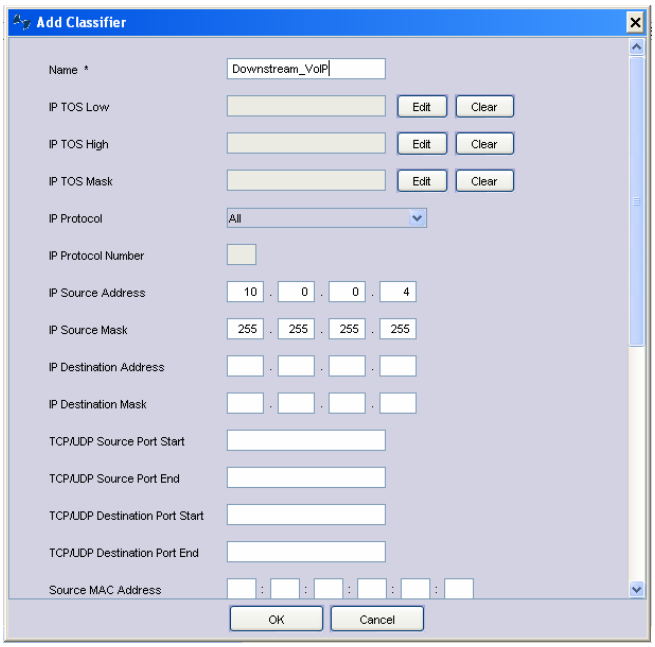
NOTE: Other classifiers that might be used include the Differentiated Services Code Point (DSCP) – typically used for QoS classification in many enterprise networks. In some VoIP implementations, multiple "servers" might be used and DSCP may be the best classifier to use. The DSCP field is sometimes called TOS (Type Of Service) and is referenced as such in the SkyPilot EMS Classifier configuration. Source or Destination UDP ports are sometimes used as classifiers.

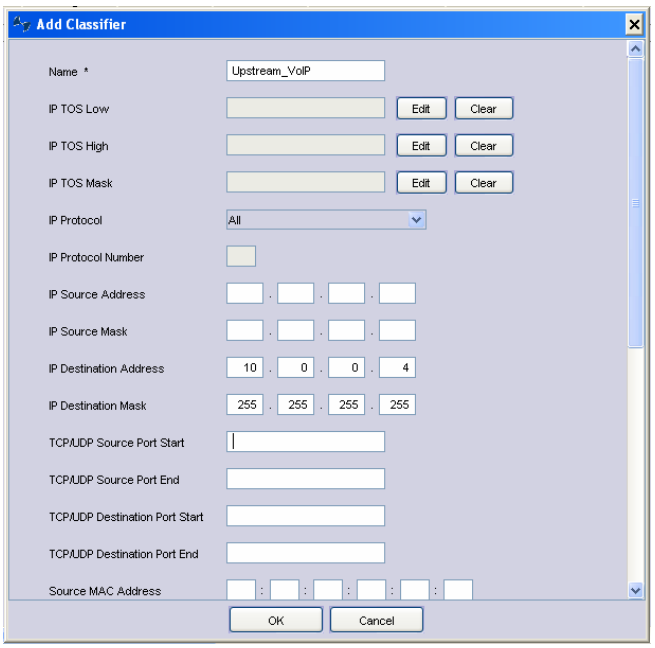
Configuring VoIP or RTP Classifiers

This is a list of steps to be used to configure classifiers through the SkyPilot EMS:

- ☐ Click **SkyProvision**
- ☐ Click the "+" next to **QoS**.
- ☐ Click "**Classifier**"
- ☐ Click "**ADD**"
- ☐ **Enter the data** as shown below – both upstream and downstream classifiers must be specified.
  - The value for "Name" can be any value that allows you to identify the classifier configured.
- ☐ Click "**OK**"

The following screenshots depict the configuration of a Upstream and Downstream Classifier for the SkyConnector. Note that the Upstream Classifier uses the Destination IP Address for the Classifier and the Downstream Classifier uses the Source IP Address for the Classifier. **It is critical to the proper implementation of the Classifiers that correct directionality be specified**.





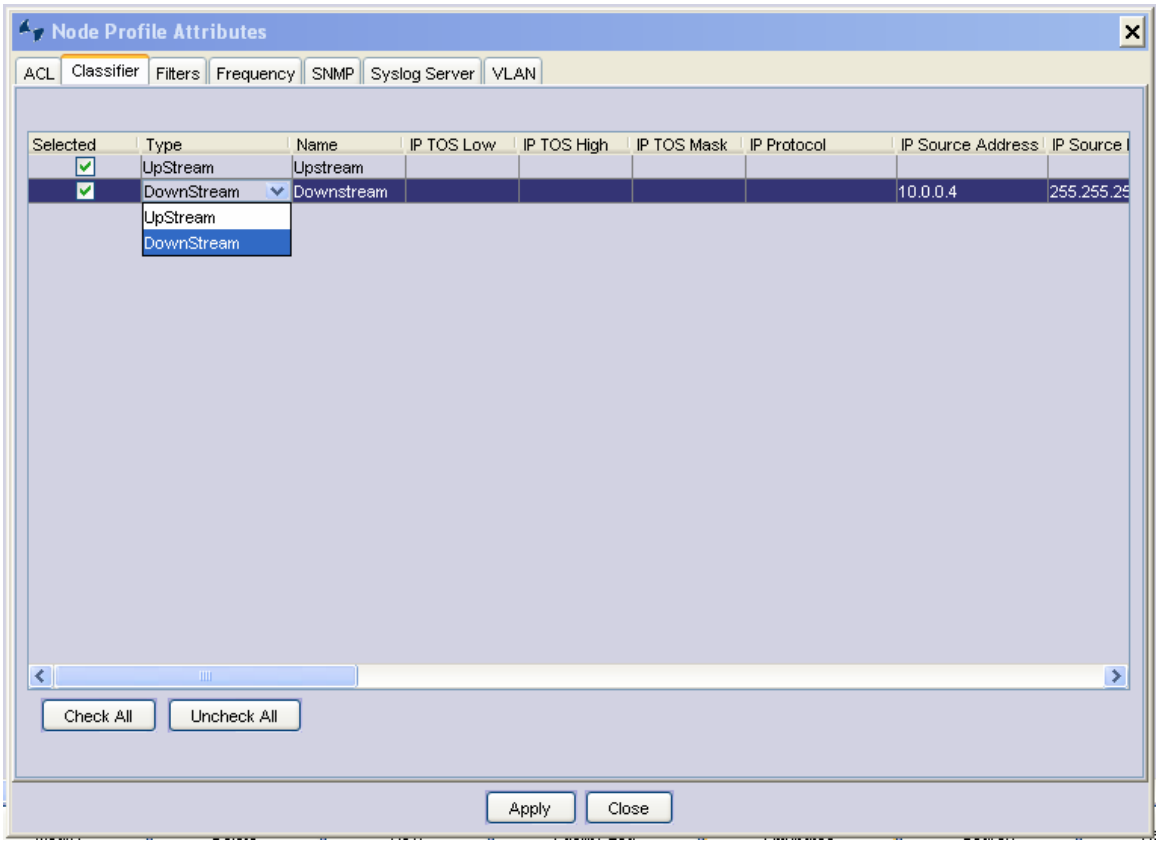
Classifier configuration is not yet complete. This step identifies the criteria used by the SkyGateway and SkyConnector to separate priority traffic from normal traffic. Directionality must be specified, in an additional step.

Configuration of Classifier Direction

The next step in configuring the classifiers is to set directionality. This is accomplished by assigning the appropriate Classifiers to the Node Profile(s) for all associated SkyConnectors and SkyExtender Ethernet port. To perform this function follow these steps:

- ☐ Click the "+" next to **SkyProvision**.
- ☐ Click **Node Profile**.
- ☐ **Select a Node Profile** for a SkyConnector you wish to prioritize VoIP for.
- ☐ From the menu on the lower portion of the screen click the "**Attributes**" button.
- ☐ Select "**Classifier**" from the tabs at the top of the Attributes screen.
- ☐ Click the box in the "**Selected**" column for both your Upstream and Downstream classifiers you wish to use.
- ☐ In the "**Type**" column configure the direction for each classifier. **THIS STEP IS CRITICAL!**
- ☐ Once the two classifiers have been selected AND the proper direction has been specified Click "**Apply**".
- ☐ **Reboot the SkyConnector**(s), **OR** log in to the device and type "**reload**", from the CLI.

These steps apply the changes to the SkyConnector(s) Node Profile and load the changes to the SkyConnector and the SkyGateway. VoIP traffic destined for 10.0.0.4 and sourced from 10.0.0.4 will be prioritized for SkyConnectors configured with the modified Node Profile. Traffic sourced from, or destined toward, 10.0.0.4 from SkyConnectors that do not have this classifier assigned to their Node Profile will not be prioritized.



QoS and Classifier – Quick Reference Sheet

This section will provide a quick checklist for the user to verify/validate the configuration of their SkyPilot network hardware. These practices should be applied to every connector on the SkyPilot network.

QoS Configuration Parameters – **ALL CUSTOMERS**

- ☐ **Downstream to Upstream Ratio** should be **10:1, or 5:1 minimum**, for all customers not using VoIP to control unnecessary upstream bandwidth. An example would be 1Mbps Downstream and 128Kbps Upstream.
- ☐ **Broadcast Rate** can be set to 10Kbps or less. A typical PC sends one 64-byte broadcast packet every 10 seconds which translates into 52bps. This will significantly reduce the impact of rogue broadcasts generated by a user. Broadcast rate limiting is applied to the downstream at the SkyGateway.

Classifiers – All Customers with VoIP or Other RTP's

- ☐ **Upstream rates assigned to customers with VoIP** should be assigned at the rate of the VoIP protocol being used **PLUS** 1/10, or 1/5 of the assigned downstream rate of transfer. As per example above, 1Mbps x 128Kbps with VoIP these values change to 1Mbps x 192Kbps.
- ☐ **Add classifiers** to use. The typical classifier used is the Source IP and Destination IP Address for the VoIP or RTP termination.
- ☐ **Determined the direction to be used by the classifier**. Typically, Source IP address classifiers will be used for downstream and Destination IP Address classifiers will be used for upstream. IP TOS (a.k.a. DSCP), Source TCP/UDP port and other fields can also be utilized for classification.
- ☐ **Configure the classifier** – Both and Upstream and a Downstream Classifier must be configured. (SkyProvision → QOS → Classifier)
- ☐ **Assign Classifier to Already Provisioned Node Profile(s)**.
    - SkyProvision → **Node Profile**
    - **Select Node Profile** to change.
    - Click "**Attributes**" button.
    - Click the "**Classifier**" tab.
    - Select **both** Upstream and Downstream by putting a √ in the box under the "**Selected**" column.
    - Ensure that the "**Type**" column matches the proper direction.
    - **Apply**

Applying Classifiers

- ☐ **Reboot the node(s)** to which classifiers were added to the node profile.

OR

- ☐ **Telnet to node**(s) and **login** to the CLI. Type: **reload** to have the unit reload its configuration.

1100 Island Drive
Redwood City, CA 94065
408.764.8000
US Toll Free 866 SKYPILOT
sales@skypilot.com