Piccolo Software-in-Loop (SiL) Setup Guide

December 4, 2009

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Table of Contents

Piccolo Software-in-Loop Setup Guide Change Log

December 4, 2009 - Software v2.1.1c

- Universal: Updated Map Actions Tool bar screen captures.

1 Introduction

This document provides first time Piccolo users a step by step guide to set up the Software-in-Loop (SiL) simulation environment. A Windows based PC is the only requirement to setup this environment.

The SiL configuration provides the same functionality as a Hardware-in-Loop (HiL) setup, but without the autopilot and ground station hardware connected. In the SiL configuration, PC applications take the place of the ground station and autopilot.

The simulation environment allows the aircraft control laws and mission functionality to be tested without risking the aircraft in a flight test. The simulation environment provides an ideal training tool that can be used in the lab. Although simulation cannot replace flight-testing, it measurably reduces the likelihood of failure by detecting bugs and deficiencies before the aircraft and related hardware are put at risk.

2 Software Installation

If you have a CD, insert it in your PC and copy all three folders from the CD to the hard drive (C) or create your own directory. The numbers behind the **Dev Kit** and **FlightGear** folders designate the latest software versions. If you are using two computers in a network, copy the same folders to both computers. If you don't have a CD, you can download these directories from our website at www.cloudcaptech.com

📁 **Dev Kit – 2.1.x**

📁 **FlightGear 0.9.10**

📁 **Maps**

2.1.1 Piccolo Command Center (PCC)

The Piccolo Command Center (PCC) is a software application that runs on a Windows PC and provides a command and control interface for Piccolo operators. Once installed, PCC can be run like any Windows application through the **Start** menu on your computer. To install the PCC, go to **Dev Kit** » **Installers**. Click **PccInstaller.msi** to launch the installer. Follow the on-screen instructions. Leave all the defaults as they are.

2.1.2 Piccolo Software

The Piccolo software includes all the tools, documents, and related support applications that allow you to setup and operate the SiL and/or HiL simulation environments. Once installed, these items can be accessed through the **Start** menu from the Cloud Cap folder. To install the Piccolo software, go to **Dev Kit** » **Installers**. Click on the **PiccoloInstaller.msi** to launch the installer. Follow the on-screen instructions.

2.1.3   FlightGear

FlightGear is an open source application that offers a visualization of the aircraft attitude. Visualization is not required for HiL or SiL simulation, but provides the user with a better way to visualize the aircraft state.

To install FlightGear, go to the **FlightGear** folder and click **fgsetup-0.9.10.exe** to launch the installer. Follow the on-screen instructions. Leave all the main defaults as they are. Uncheck the **Launch FlightGear** box at the end of the installation. For the Simulator to work in synchronize with FlightGear, parameters for FlightGear must be set up and configured correctly. The batch file **runfgfs-c172-netctrl.bat** in the FlightGear directory does this for you. You can use this batch file to start FlightGear from this location, but we recommended creating a shortcut and starting it from the desktop.

2.2   Start SiL Simulation

1. On your computer, go to the **Start** » **Programs** » **Cloud Cap** » **Start airplane or helicopter software simulation.** This automatically launches all the SiL applications required to run a simulation.

    Note: v2.1.1.b v2.1.1.c software does not support helicopter operations at this time.
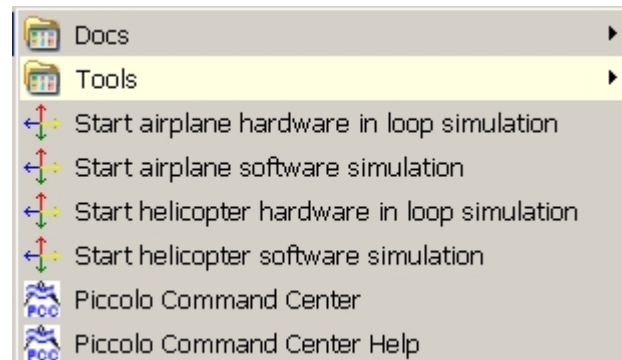
Figure 1 - Simulation Start Menu

2. The **Communications** window for the PCC opens. This window configures the system to allow all the SiL applications to talk to one another. Since the Ground Station and PiccoloPC applications are on the same computer, leave the default settings as they are,
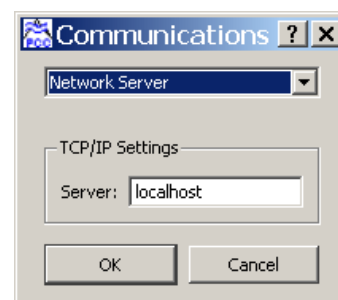
Figure 2 - Communications Window

2.2.1 Piccolo Command Center Display

In **Figure 3** there is one autopilot in the network and the `Layers`, `Aircraft`, and `Primary Flight Display` windows are docked to the main map window. The map window of the Piccolo PC is the largest display, and the most important. It cannot be turned off, moved or docked. All other windows are docked with respect to it.

Note: The red ring represents the ground station location at the San Francisco airport and the aircraft icon is in the center of the ring.

Troubleshooting Tip: Some computer Firewalls may not allow local TCP connections and could interfere with setting up a suitable SiL environment. If you are having trouble establishing the SiL, check the Firewall settings and restart the SiL.
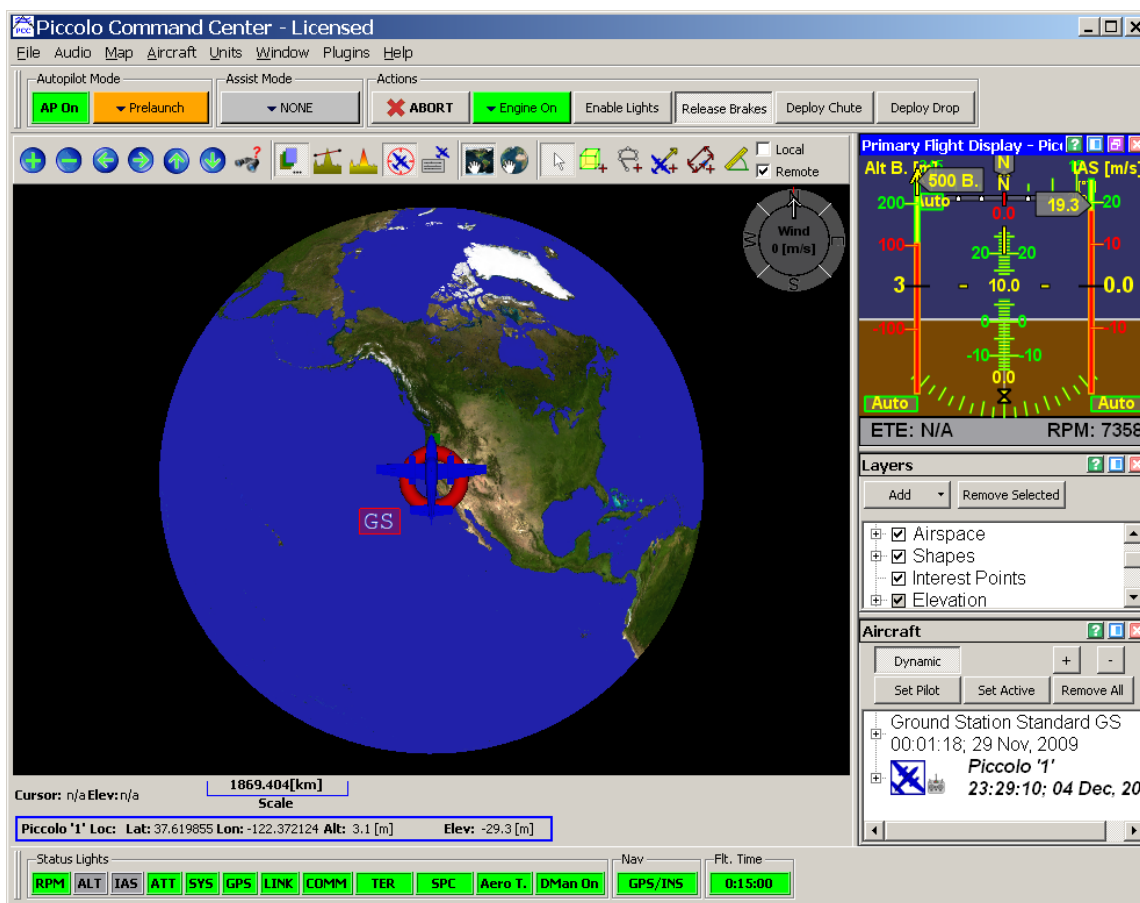
Zooms the map in or out. Hold the buttons down to do a continuous zoom.

Pan the map left, right, up, or down, but only if the map is not in "follow active aircraft mode". Hold the button down to pan continuously.

For more information on how to use the PCC interface, see the *Piccolo User's Guide*.

Figure 3 - Piccolo Command Center Display

2.3   Layers

Layers is a dockable window for selecting layers that are displayed on the map. There are seven categories of layers. Each layer has its own subcategory.

- To enable or disable a layer, click the check box next to the layer.

- To remove a layer completely, from the map and layer list, select it, and then click the **Remove Selected** button.

- To go to a image layer you have added to the map, right click on the image layer and select **View on Map**.

See the *Piccolo User's Guide* for more information about this window.
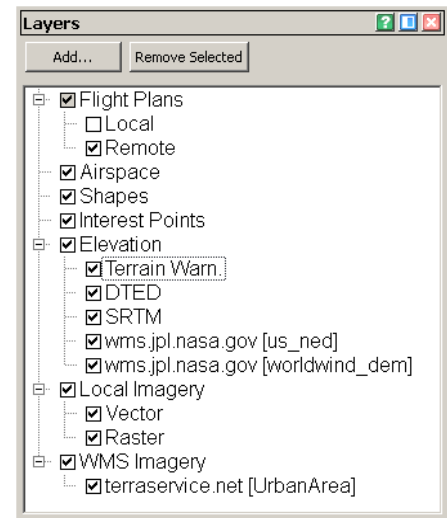
Figure 4 - Layers Window

2.3.1   Local Imagery Layer

Local imagery is a raster or vector map layer that only exists locally, i.e. on the hard drive.

2.3.2   WMS Imagery Layer

This imagery data is downloaded automatically from online sources specified by the user.

2.3.3   Adding Layers

To add a layer, click the **Add** button in the **Map Layers** window and select the type of layer to add to the map window (local images, elevation data or online imagery WMS). For local images and elevation data you can navigate to the directory where this information is stored. Click the **Open** button to add the layer to the **Map** window.

Note: CCT includes a basic map directory with the installation CD or you can download the same map directory from the Piccolo software page.
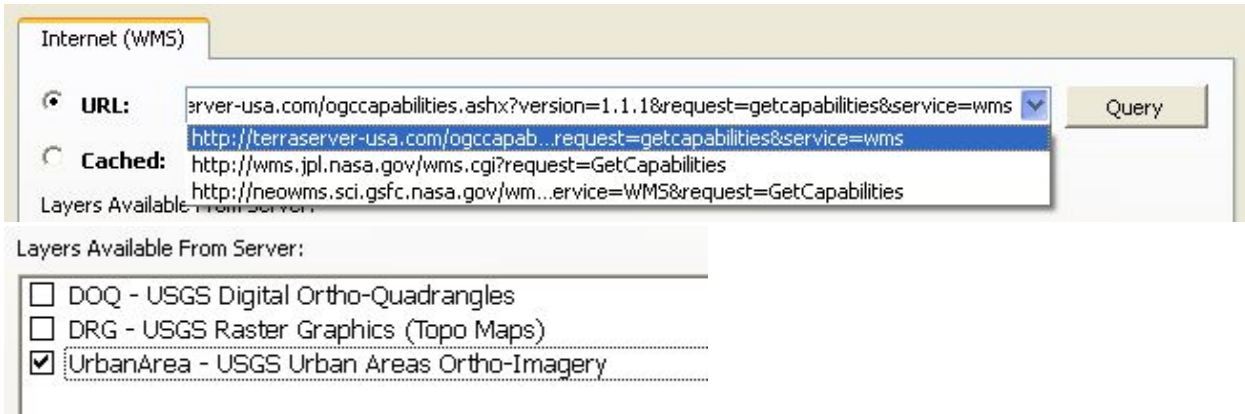
Map layers coming from the internet are referred to as WMS (Web Mapping Service). WMS defines a protocol that allows applications to query a map server for its capabilities. For example, the *terraserver*, a popular internet map service, supports three different map types:

- Uurban area imagery - 0.5 meter resolution in color, but only available in some large US cities

- Digital Orthographic Quadrangles (DOQ) - 1 meter resolution in black and white

- Topographic maps

For maps outside the U.S., select the *wms.jpl.nasagov* server and then select *global_mosaic – WMS Global Mosaic, pan sharpened*. The global mosaic layer is worldwide Landsat data with a 15 meter resolution. There are commercial services that offer WMS mapping data, such as GlobeXPlorer (http://www.globexplorer.com/products/imageconnect-wms.shtml).

To add map layers from the Internet:

1. Select **WMS** from the `Add` button menu.

2. Select the **URL** radio button. From the pull down menu, select a URL address to the server where you would like to obtain maps. The PCC has three default servers configured. More servers are available. You can also type in a WMS URL.


Figure 5 - Internet (WMS)

3. Click the `Query` button. The options from the server are displayed in the `Layers Available From Server` window.

4. Select the layers you would like to see displayed in the `Map` window.

5. Click the **Add Layer** » button. This populates the **Layers to Add** window.

6. Click the **Add Layers** » button. This adds the layers to the **Map** window. The map layers should become visible in the **Map** window.

Note: WMS layers are dynamic, automatically downloading map information in the correct location and resolution to match the current map settings. When using WMS layers it may take some time to get an adequate map to appear; however WMS data is cached locally in the user application or PCC program directory, in a directory called WMSCACHE. Once maps are downloaded, you may copy this directory to archive it or transfer it to another machine's PCC installation.

The window in **Figure 6** gives an overview of what the PCC looks like with and urban area map of the San Francisco airport loaded from TerraServer.
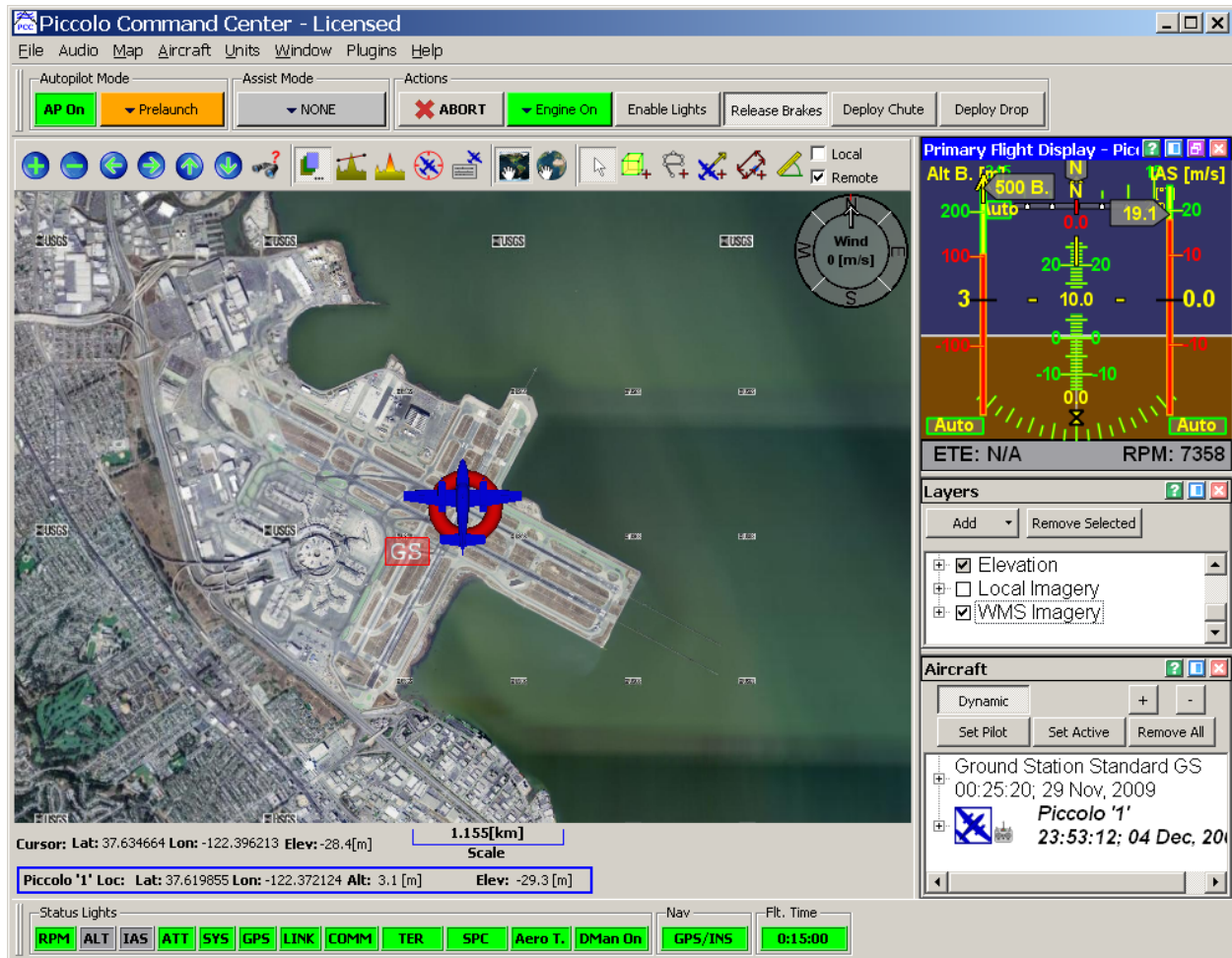
Figure 6 - WMS Imagery Layer

Note: WMS layers are dynamic, automatically downloading map information in the correct location and resolution to match the current map settings. When using WMS layers it may take some time to get an adequate map to appear; however WMS data is cached locally in the user application or PCC program directory, in a directory called WMSCACHE. Once maps are downloaded, you can copy this directory to archive it or transfer it to another machine's PCC installation.

2.3.4 Geo-Referencing a Map File

If you have an image of the area you wish to fly and you want to use this image for your map you will need to geo-reference it. The map will accept geo-referenced TIFF image files. Your first step is to get your image in TIFF format. The geo-referencing is done through a separate file, called a world file that has the same name as the image file, but with the extension "tfw". The world file contains six numbers, one on each line, and has the following format:

```
degrees longitude per x pixel
0
0
degrees latitude per y pixel (negative)
```

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Longitude of the upper left corner (positive East) Latitude of the upper left corner (positive North) The geo-referencing assumes that the image is linear, therefore it must be a rectilinear projection, and it must be oriented so that North and South are in the vertical direction. Note that the y-axis scale factor should be negative; this is a result of computer graphics coordinates systems which increase downwards. An example world file, which is for Wasco airport in Oregon, follows:

0.00005140576	0.00000000	-120.68207806
0.00000000	-.00005140576	45.591328

3   Simulator

When the SiL is started, the Simulator application launches with a dynamics model of a small Piper Cub aircraft.

☑ From the Simulator window, open the **External** menu and verify that **AP Simulation** is checked. This allows the Simulator to talk to the PiccoloPC application. If **AP Simulation** is not checked, it means Simulator cannot find the PiccoloPC application.

☑ If the Simulator cannot find the PiccoloPC application, check the settings on your computer Firewall. Some Firewalls may not allow local TCP connections and could interfere with setting up a suitable SiL environment.
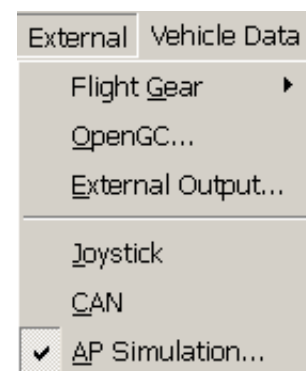

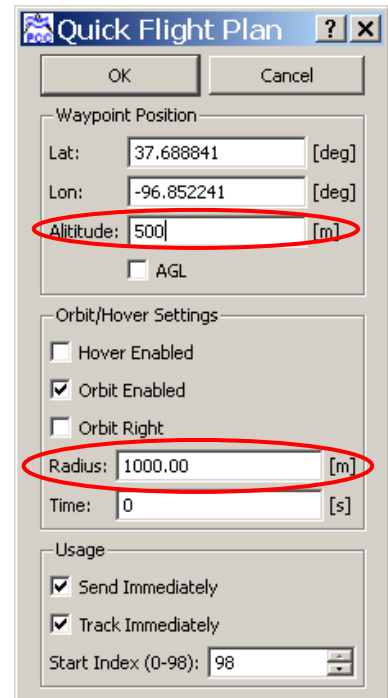**Figure 7 - External Menu**

4   Create a Quick Flight Plan

1. To create a simple flight plan, select the **Quick Flight Plan** icon on the map actions toolbar.

Figure 8 - Map Actions Toolbar

Piccolo SiL Setup Guide 12-04-09 **GOODRICH** Page 10 of 13

2. Move your mouse over to the map and click anywhere in the map area that you want to create a plan. The **Quick Plan** window opens (**Figure 9**) and displays the latitude and longitude of the position that was clicked in the map. In this window you can enable an orbit flight plan and select the altitude and radius for the aircraft to fly in.

3. For this simulation, enter a 500 meter altitude and a 1000 meter radius and click **OK**. See the *Map* section in the *Piccolo User's Guide* for more information on how to create detailed flight plans.
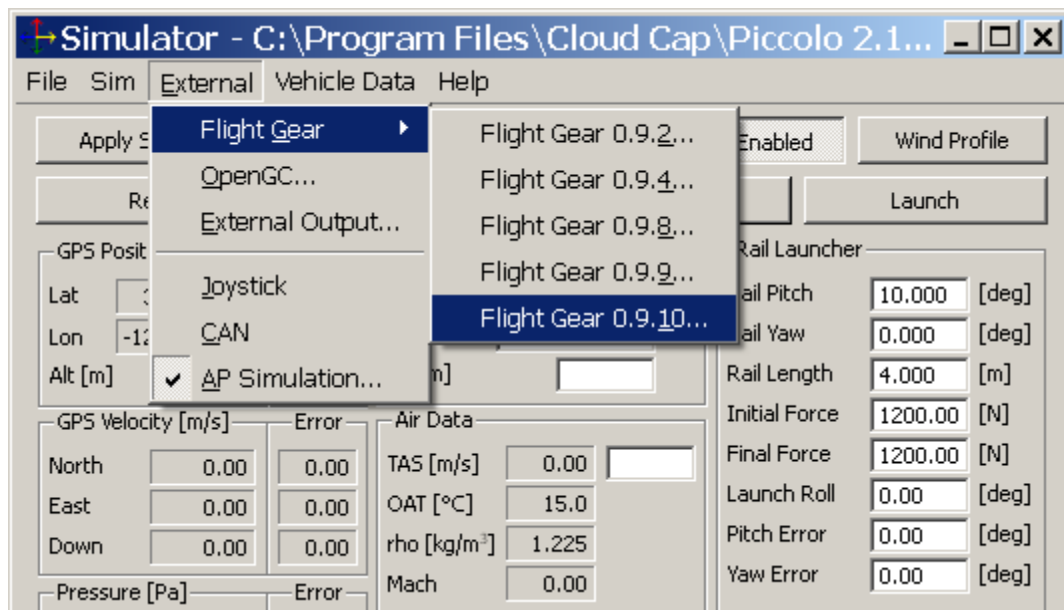
   When the aircraft is launched it will climb to the altitude set in this flight plan and fly in a 1000 meter radius of where you initially clicked on the map.

Figure 9 - Quick Flight Plan
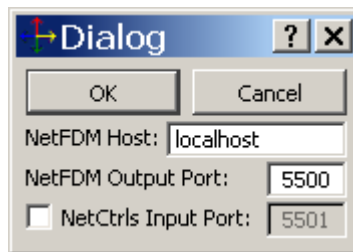
4.1 FlightGear

1. If you wish to use FlightGear for visualization, open the **External** menu and select the latest version of FlightGear that is on your PC.

Figure 10 - FlightGear

2. If FlightGear, Simulator, and PCC are installed on the same computer, leave the default in the **Host** field as "localhost" (**Figure 11**). If FlightGear is installed on a separate computer, enter the computer's IP address or the name of the FlightGear computer in the **Host** field. Click **OK.** Click **OK**.

*Note: To determine the IP address of your computer. Open a Microsoft DOS command prompt shell window by clicking the **Start** menu at the lower-left of your computer's desktop and select **Run**. If you are using Windows XP or Vista, type "cmd" (without quotation marks) into the **Run** box and click **OK**. Otherwise, type "command" (without quotation marks) into the **Run** box and click **OK**. In the command prompt window, type in "ipconfig" and press **Enter** on your keyboard.*
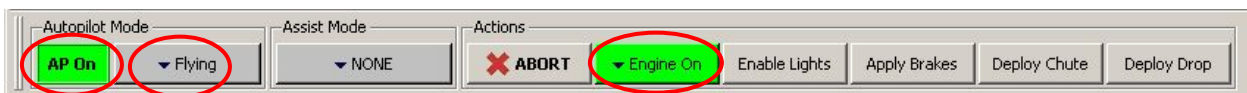

Figure 11 - FlightGear Comms Dialog

3. Start FlightGear using the supplied batch file **runfgfs-c172-netctrl.bat**.

5   Launching the Aircraft

4. From the PCC window, verify the following:

- ☑ The aircraft is in Prelaunch mode.

- ☑ The AP is on.

- ☑ The engine is on.

Figure 12 - Aircraft Actions Toolbar

5. Click **Launch** from the **Simulator** screen. Control of the aircraft is performed by Piccolo, and your interaction with the system is through the Piccolo Command Center.

Note: Once the dynamics model is loaded, you can change the state of the simulation. See the Piccolo Simulator document for more information on modifying this dynamics model.

6. Once the aircraft is flying, you may wish to perform basic flight tasks with the aircraft. See the *Piccolo User's Guide* for more information on how to:

- Create a multipoint flight plan

- Create a landing plan

- Create an airspace boundary

- Track a waypoint

- View a bread crumb trail

- Change aircraft altitude

If you are having problems setting up the SiL environment, contact us by e-mail at support@cloudcaptech.com or phone at +1.541.387.2120.

6 SiL Checklist
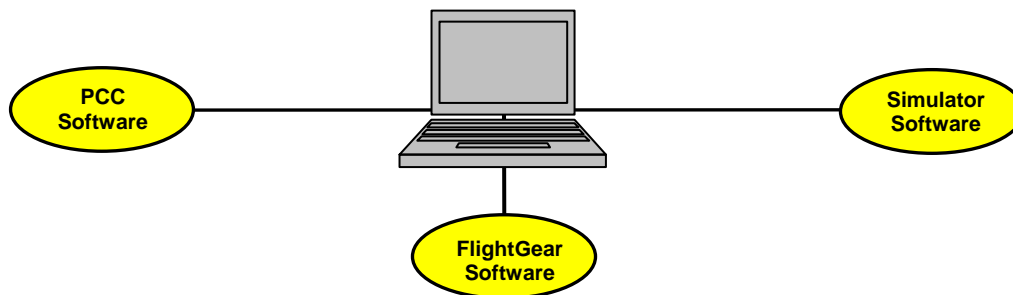
Figure 13 - SiL Environment

☑ Load the software to the PC.

☑ Start the Software-in-Loop Simulation.

☑ Verify communication between Piccolo and the ground station.

☑ Verify that AP Simulation is checked in the Simulator window.

☑ From the Piccolo Command Center window, create a simple flight plan.

☑ From the Simulator window, select the latest version of FlightGear.

☑ Enter the address of the FlightGear PC (if needed).

☑ Start FlightGear using the batch file *runfgfsnet-c172.bat.*

☑ Launch the aircraft from the Simulator window.