FlightGear READMEs

FlightGear Community

January 21, 2014

Contents

1 Introduction

This document is autogenerated from the various plain text README files found in the Docs/ directory of your FlightGear installation, presented in PDF format for ease of use. These are targetted at those delving into the internals of FG, or developing aircraft.

For help running or using FlightGear, please see Docs/getstart.pdf.

2 3DClouds

```
Configuring 3D Clouds
=====================

3D clouds can be created in two ways:
- By placing individual clouds using a command (e.g. from Nasal)
- Using the global weather function, which reads cloud definition from
  an XML file.

Placing Clouds Individually
===========================

Clouds are created using the "add-cloud" command, passing a property
node defining the location and characterstics of the cloud.

Location is defined by the following properties:

<layer>      - The cloud layer number to add the cloud to. (default 0)
<index>      - A unique identifier for the cloud in the layer. If a cloud
```

```
               already exists with this index, the new cloud will not be
               created, and 0 is returned.
<lon-deg>    - Longitude to place the cloud, in degrees (default 0)
<lat-deg>    - Latitude t place the cloud, in degrees (default 0)
<alt-ft>     - Altitude to place the cloud, relative to the layer (!) in ft
               (default 0)
<x-offset-m> - Offset in m from the lon-deg. +ve is south (default 0)
<y-offset-m> - Offset in m from the lat-deg. +ve is east (default 0)

The cloud itself is built up of a number of "sprites" - simple 2D textures
that are always rotated to be facing the viewer. These sprites are handled
by a OpenGL Shader - a small program that is run on your graphics card.

The cloud is defined by the following properties:

<min-cloud-width-m>   - minimum width of the cloud in meters (default 500)
<max-cloud-width-m>   - maximum width of the cloud (default min-cloud-width-m*1.5)
<min-cloud-height-m>  - minimum height of the cloud (default 400)
<max-cloud-height-m>  - maximum height of the cloud (default min-cloud-height-m*1.5)
<texture>             - texture file of sprites to use (default cl_cumulus.png)
<num-textures-x>      - number of cloud textures defined horizontally in the
                        texture file (default 4)
<num-textures-y>      - number of cloud textures defined vertically in the
                        texture file (default 4)
<height-map-texture>  - whether to choose the vertical texture index based on
                        sprite height within the clouds (default false)
<num-sprites>         - Number of sprite to generate for the cloud (default 20)
<min-sprite-width-m>  - minimum width of the sprites used to create the cloud
                        (default 200)
<max-sprite-width-m>  - maximum width of the sprites used to create the cloud
                        (default min-sprite-width-m*1.5)
<min-sprite-height-m> - minimum height of the spites used to create the cloud
                        (default 150)
<max-sprite-height-m> - maximum height of the sprites used to create the cloud
                        (default min-sprite-height-m*1.5)
<z-scale>             - vertical scaling factor to apply to to the sprite after
                        billboarding. A small value would create a sprite that
                        looks squashed when viewed from the side. (default 1.0)
<min-bottom-lighting-factor> - See Shading below (default 1.0)
<max-bottom-lighting-factor> - See Shading below (default min-...-factor + 0.1)
```

<min-middle-lighting-factor> - See Shading below (default 1.0)
<max-middle-lighting-factor> - See Shading below (default min-...-factor + 0.1)
<min-top-lighting-factor>   - See Shading below (default 1.0)
<max-top-lighting-factor>   - See Shading below (default min-...-factor + 0.1)
<min-shade-lighting-factor> - See Shading below (default 0.5)
<max-shade-lighting-factor> - See Shading below (default min-...-factor + 0.1)

Shading
----

the [min|max]-...-lighting-factor properties allow you to define diffuse lighting multipliers to the bottom, middle, top, sunny and shaded parts of the cloud. In each case, individual clouds will have a random multiplier between the min and max values used to allow for some variation between individual clouds.

The top, middle and bottom lighting factors are applied based on the pixels vertical positon in the cloud. A linear interpolation is used either between top/middle (if the pixel is above the middle of the cloud) or middle/bottom (if the pixel is below the middle of the cloud).

The top factor is also applied to _all_ pixels on the sunny side of the cloud. The shade factor is applied based on the pixel position away from the sun, linearly interpolated from top to shade. E.g this is not a straight linear interpolation from top to shade across the entire cloud.

The final lighting factor is determined by the minimum of the vertical factor and the sunny/shade factor. Note that this is applied to the individual pixels, not sprites.

Textures

The texture to use for the sprites is defined in the <texture> tag.
To allow some variation, you can create a texture file containing multiple sprites in a grid, and define the <num-textures-x/y> tags. The code decides which texture to use for a given sprite : randomly in the x-direction and based on the altitude of the sprite within the cloud in the y-direction if <height-map-texture> is set. Therefore, you should put sprite textures you want to use for the bottom of your cloud at the bottom of the texture file, and those you want to use for the top of the cloud at the top of the

texture file.

For example, the following Nasal snippet will create a cloud immediately above the aircraft at an altitude of 1000 ft above /environment/clouds/layer[0]/elevation-ft :

```
var p = props.Node.new({ "layer" : 0,
                         "index": 1,
                         "lat-deg": getprop("/position/latitude-deg"),
                         "lon-deg": getprop("/position/longitude-deg"),
                         "alt-ft" : 1000 });
fgcommand("add-cloud", p);
```

Moving Individual Clouds
========================

Clouds may be moved by using the "move-cloud" command. This takes the following property arguments.

```
<layer>      - The cloud layer number containing the cloud to move. (default 0)
<index>      - The unique identifier of the cloud to move.
<lon-deg>    - Longitude to place the cloud, in degrees (default 0)
<lat-deg>    - Latitude t place the cloud, in degrees (default 0)
<alt-ft>     - Altitude to place the cloud, relative to the layer (!) in ft
               (default 0)
<x-offset-m> - Offset in m from the lon-deg. +ve is south (default 0)
<y-offset-m> - Offset in m from the lat-deg. +ve is east (default 0)
```

Deleting Individual Clouds
==========================

Clouds may be deleted by using the "del-cloud" command. This takes the following property arguments.

```
<layer>      - The cloud layer number containing the cloud to delete. (default 0)
<index>      - The unique identifier of the cloud to delete.
```

Global 3D Clouds
================

The global weather system uses sets of clouds defined in

FG_ROOT/Environment/cloudlayers.xml

The file has 3 distinct sections: layers, cloud boxes and clouds,
described below.

Notes for those editing clouds:
- All distances are in m. Note that this is in contrast to cloud heights
  in METAR etc. which are in ft.
- The XML file is loaded into the properties system, so you can modify
  the settings in-sim, and see the results by re-generating the cloud
  layer. The simplest way to do this is to disable METAR, and control
  the cloud layers using the Clouds dialog, and in particular the coverage.
- Texture files are in .png format, and have a transparent background.
  To make the textures easier to edit, create a black layer behind them,
  so there is some contrast between the background and the white cloud.
  Having a grid based on the texture dimensions also helps, so you don't
  bleed over the edges, which causes ugly sharp horizontal and vertical
  lines.

Clouds
======

The cloud definitions are as described above for placing individual
clouds, but no position information is used (this is defined in the
cloud box and layers below).

Cloud Boxes
===========

The <boxes> section contains definitions of groups of cloads,for example
an entire towering CB mass.

The <boxes> section contains a number of named types, which are referenced
by the <layers> section, described below. Therefore, the names used are
completely user-defined.

Each of the named section consists of one or more <box> section,
defining a particular cloud type

Each <box> section contains the following tags:

```
<type>   - The cloud to use, defined above
<count>  - The number of clouds to generate (+/- 50%)
<width>  - The x and y within which these clouds should be generated
<height> - The height within which the clouds should be generated
<hdist>  - The horizontal distribution of the clouds within the area.
           Equates to a sum of random distributions. Defaults to 1.
           1 = even distribution, 2 = distributed towards the center.
           3 = very strongly distributed towards the center.
<vdist>  - The vertical distribution of the clouds. As for hdist.
```

If the /sim/rendering/clouds3d-density is less than 1.0 (100%), then a proportional number of clouds will be displayed.

The following example shows a stratus cloud group, which consists of 5 st-large clouds and 5 st-small clouds, distributed in a box 2000mx2000m, and 100m high, evenly distributed.

```
    <st>
      <box>
        <type>st-large</type>
        <count>5</count>
        <width>2000</width>
        <height>100</height>
      </box>
      <box>
        <type>st-small</type>
        <count>5</count>
        <width>2000</width>
        <height>100</height>
      </box>
    </st>
```

Layers

The <layers> section contains definitions for a specific layer type. The layer type is derived from the METAR/Weather settings by FG itself.

Each layer type is a named XML tag, i.e.: ns, sc, st, ac, cb, cu.
If a layer type is not defined, then a 2D layer is used instead.

The layer type contains one or more <cloud> definitions. This
defines a type of cloud box, and a weighting for that type (<count>).

For example, the following XML fragment will produce 3 "cb" cloud boxes
for every 1 "cu":

```
<cloud>
    <name>cb</name>
    <count>3</count>
</cloud>
<cloud>
    <name>cu</name>
    <count>1</count>
</cloud>
```

Clouds are randomly distributed across the sky in the x/y plane, but the
height of them is set by the weather conditions, with a random height range
applied, defined by <grid-z-rand>

3 Airspeed-indicator

The airspeed indicator can be initialized in an instrumentation.xml file.
If not specified, the generic indicator will be loaded
from the Aircraft/Generic/generic-instrumentation.xml.

The normal setup is :

```
  <airspeed-indicator>
    <name>airspeed-indicator</name>
    <number>0</number>
    <total-pressure>/systems/pitot/total-pressure-inhg</total-pressure>
    <static-pressure>/systems/static/pressure-inhg</static-pressure>
    <has-overspeed-indicator>1</has-overspeed-indicator>
  </airspeed-indicator>
```

```
Of course the total and static pressure may be sourced from any other
pitot and static system when defined:

  <airspeed-indicator>
    <name>airspeed-indicator</name>
    <number>1</number>
    <total-pressure>/systems/pitot[1]/total-pressure-inhg</total-pressure>
    <static-pressure>/systems/static[1]/pressure-inhg</static-pressure>
    <has-overspeed-indicator>0</has-overspeed-indicator>
  </airspeed-indicator>

Note that the Aircraft/Generic/generic-systems.xml only initiates one
pitot and one static system, see also README.systems

<total-pressure> is optional --- defaults to "/systems/pitot/total-pressure-inhg"
For supersonic aircraft with an airspeed indicator NOT compensating for
a shockwave in front of the pitot tube (most probably the case), use:
<total-pressure>/systems/pitot/measured-total-pressure-inhg</total-pressure>

<static-pressure> is optional --- defaults to "/systems/static/pressure-inhg"
<has-overspeed-indicator> is optional --- defaults to 0 / off

The <has-overspeed-indicator> provides a property for "barber-pole" animation,
 and is set to 0 / false by default ,

If enabled , these properties should be added in the aircraft -set file,
with that aircraft's correct figures.

    <airspeed-indicator>
        <ias-limit>248.0</ias-limit>
        <mach-limit>0.48</mach-limit>
        <alt-threshold>13200.0</alt-threshold>
    </airspeed-indicator>


The default values are for a Beechcraft B1900D .

<ias-limit> is the aircraft's VNE (never exceed speed) in KIAS

<mach-limit> Mach speed limit.
```

<alt-threshold> altitude at which these figures were calculated.

Note : <mach-limit> is the mach limit at <alt-threshold>
This was designed for indicated airspeed limits, but could probably be extended
for mach limits.

To initiate additional airspeed indicators, add in your instrumentation
file (for airspeed indicator index 1):

```
  <airspeed-indicator>
    <name>airspeed-indicator</name>
    <number>1</number>
    <total-pressure>/systems/pitot[1]/total-pressure-inhg</total-pressure>
    <static-pressure>/systems/static[1]/pressure-inhg</static-pressure>
    <has-overspeed-indicator>0</has-overspeed-indicator>
  </airspeed-indicator>
```

Note: this airspeed indicator sources its pressures from the second
pitot and static system (with index 1).
and in the aircraft -set file:

```
    <airspeed-indicator n="1">
          <serviceable type="bool" archive="y">true</serviceable>
    </airspeed-indicator>
```

And if "has-overspeed-indicator" = 1, the appropriate limits as explained
above in the airspeed-indicator brackets.

4 Checklists

CHECKLISTS

You can create one or more checklist for an aircraft under /sim/checklists. These
are intended to mimic the checklists of aircraft themselves, and can be found under
the Help->Checklists menu within the simulator.

Tutorials are automatically generated from checklists on startup.

Each checklist is defined as a property tree under /sim/checklists/checklist[n]
with the following tags

```
<title>       - Name of the checklist
<page>        - Zero or more pages for the checklist containing:
 <item>       - One or more checklist items containing:
  <name>      - name of the checklist item (e.g. Carb Heat), to appear on the left
  <value>     - One or more values for the checklist item, to appear on the right
                hand side
  <marker>    - A tutorial marker (displayed when the user presses the ? button)
                This can be easily placed using the Help->Display Tutorial Marker.
                Contains x-m, y-m, z-m and scale tag.
  <condition> - Optional standard FlightGear condition node that evaluates when the
                checklist item has been completed.
  <binding>   - Zero or more bindings to execute the checklist item.  Allows the user
                to have their virtual co-pilot perform the action if they select the
                ">" button next to the checklist item.
```

The <page> tag may be omitted for single-page checklists, with the <item> tags
immediately under the <checklist[n]> node.

See the c172p for an example of this in action (Aircraft/c172p/c172-checklists.xml).

5 Commands

FlightGear Commands Mini-HOWTO

David Megginson
Started: 2002-10-25
Last revised: 2007-12-01

In FlightGear, a *command* represents an action, while a *property*
represents a state. The trigger for a command can be any kind of user
input, including the keyboard, mouse, joystick, GUI, instrument panel,
or a remote network client.

XML Command Binding Markup

Most of the command-binding in FlightGear is handled through static XML configuration files such as $FG_ROOT/keyboard.xml for the keyboard, $FG_ROOT/mice.xml for the mouse, and $FG_ROOT/gui/menubar.xml for the menubar. In all of these files, you reference a command through a binding. This binding advances the first throttle by 1%, up to a maximum value of 1.0:

```
<binding>
 <command>property-adjust</command>
 <property>/controls/throttle[0]</property>
 <step type="double">0.01</step>
 <max>1.0</max>
</binding>
```

A command binding always consists of the XML 'binding' element, with one subelement named 'command' containing the command name (such as 'property-adjust'). All other subelements are named parameters to the command: in this case, the parameters are 'property', 'step', and 'max'. Here is a simpler binding, with no parameters:

```
<binding>
 <command>exit</command>
</binding>
```

Bindings always appear inside some other kind of markup, depending on the input type. For example, here is the binding from keyboard.xml that links the ESC key to the 'exit' command:

```
<key n="27">
 <name>ESC</name>
 <desc>Prompt and quit FlightGear.</desc>
 <binding>
   <command>exit</command>
 </binding>
</key>
```

Usually, more than one binding is allowed for a single input trigger,
and bindings are executed in order from first to last. Bindings support
conditions (see README.conditions):

```
 <key n="113">
  <name>q</name>
  <desc>Test</desc>

  <binding>
   <condition>
    <property>/devices/status/mice/mouse/button[0]</property>
   </condition>
   <command>nasal</command>
   <script>print("mouse button 0 pressed")</script>
  </binding>
 </key>
```

Keyboard definitions can embed bindings in tags <mod-up> (key released),
<mod-shift>, <mod-ctrl>, <mod-alt>, <mod-meta>, <mod-super>, and <mod-hyper>.
Nesting is supported. Meta, Super, and Hyper modifier tags are for local
use only, and must be supported by the operating system to work.

```
 <key n="113">
  <name>q</name>
  <desc>Test</desc>
  <binding>
   <command>nasal</command>
   <script>print("q pressed")</script>
  </binding>

  <mod-alt>
   <binding>
    <command>nasal</command>
    <script>print("Alt-q pressed")</script>
   </binding>

   <mod-super>
    <binding>
     <command>nasal</command>
```

```
     <script>print("Alt-Super-q pressed")</script>
    </binding>

    <mod-meta>
     <binding>
      <command>nasal</command>
      <script>print("Alt-Super-Meta-q pressed")</script>
     </binding>

    </mod-meta>
   </mod-super>
  </mod-alt>
 </key>
```

Built-in Commands

As of the last revision date, the following commands were available from inside FlightGear; the most commonly-used ones are the commands that operate on property values (FlightGear's internal state):

```
null - do nothing

script - execute a PSL script
  script: the PSL script to execute

exit - prompt and quit FlightGear

pause - pause/resume the simulation

load - load properties from an XML file
  file: the name of the file to load, relative to the current
    directory (defaults to "fgfs.sav")

save - save properties to an XML file
  file: the name of the file to save, relative to the current
    directory (defaults to "fgfs.sav").
```

```
loadxml - load XML file into property tree
  filename: the path & filename of the file to load
  targetnode: the target node within the property tree where to store the XML
  file's structure. If targetnode isn't defined, then the data will be stored
  in a node "data" under the argument branch.

savexml - save property tree node to XML file
  filename: the path & filename for the file to be saved
  sourcenode: the source node within the property tree where the XML file's
  structure is assembled from. If sourcenode isn't defined, then savexml will
  try to save data stored in a node "data" in the argument branch.

panel-load - (re)load the 2D instrument panel
  path: the path of the XML panel file, relative to $FG_ROOT (defaults
    to the value of /sim/panel/path if specified, or
    "Panels/Default/default.xml" as a last resort.

panel-mouse-click - pass a mouse click to the instrument panel
  button: the number of the mouse button (0-based)
  is-down: true if the button is down, false if it is up
  x-pos: the x position of the mouse click
  y-pos: the y position of the mouse click

preferences-load - (re)load preferences
  path: the file name to load preferences from, relative to $FG_ROOT.
    Defaults to "preferences.xml".

view-cycle - cycle to the next viewpoint

screen-capture - capture the screen to a file

tile-cache-reload - reload the scenery tile cache

lighting-update - update FlightGear's lighting

property-toggle - swap a property value between true and false
  property: the name of the property to toggle

property-assign - assign a value to a property
```

```
  property[0]: the name of the property that will get the new value.
  value: the new value for the property; or
  property[1]: the name of the property holding the new value.

property-interpolate - assign a value to a property, interpolated
                       over time
  property[0]: the name of the property that will get the new value
               and defines the starting point of the interpolation
  value:       the new value for the property; or
  property[1]: the name of the property holding the new value.
  time:        the time in seconds it takes for the transition from the
               old value to the new value of property[0]; or
  rate:        the ammount of change per second the value of property[0] changes
               to transition to the new value

property-adjust - adjust the value of a property
  property: the name of the property to increment or decrement
  step: the amount of the increment or decrement (defaults to 0)
  offset: input offset distance (used for the mouse; multiplied by
    factor)
  factor: factor for multiplying offset distance (used for the mouse;
    defaults to 1)
  min: the minimum allowed value (default: no minimum)
  max: the maximum allowed value (default: no maximum)
  mask: 'integer' to apply only to the left of the decimal point;
    'decimal' to apply only to the right of the decimal point; 'all'
    to apply to the full value (defaults to 'all')
  wrap: true if the value should be wrapped when it passes min or max;
    both min and max must be specified (defaults to false)

property-multiply - multiply the value of a property
  property: the name of the property to multiply
  factor: the amount by which to multiply (defaults to 1.0)
  min: the minimum allowed value (default: no minimum)
  max: the maximum allowed value (default: no maximum)
  mask: 'integer' to apply only to the left of the decimal point;
    'decimal' to apply only to the right of the decimal point; 'all'
    to apply to the full value (defaults to 'all')
  wrap: true if the value should be wrapped when it passes min or max;
    both min and max must be specified (defaults to false)
```

```
property-swap - swap the values of two properties
  property[0]: the name of the first property
  property[1]: the name of the second property

property-scale - set the value of a property based on an axis
  property: the name of the property to set
  setting: the current input setting (usually a joystick axis from -1
    or 0 to 1)
  offset: the offset to shift by, before applying the factor (defaults
    to 0)
  factor: the factor to multiply by (use negative to reverse; defaults
    to 1.0)
  squared: if true will square the resulting value (same as power=2)
  power: the resulting value will be taken to the power of this integer
    value (overrides squared; default=1)

property-cycle - cycle a property through a set of values
  property: the name of the property to cycle
  value[*]: all of the allowed values

dialog-new - create new dialog from the argument branch

dialog-show - show an XML-configured dialog box
  dialog-name - the name of the dialog to show

dialog-close - close the active dialog box

dialog-update - copy values from FlightGear to the active dialog box
  object-name: the name of the GUI object to update (defaults to all
    objects)

dialog-apply - copy values from the active dialog box to FlightGear
  object-name: the name of the GUI object to apply (defaults to all
    objects)

presets-commit - commit preset values from /sim/presets

open-browser - open the web browser and show given file
   path: name of the local file to be opened.
```

```
   url: URL to be opened (http://..., ftp://...).

The following commands are temporary, and will soon disappear or be
renamed; do NOT rely on them:

old-save-dialog - offer to save a flight

old-load-dialog - offer to load a flight

old-reinit-dialog - offer to reinit FlightGear

old-hires-snapshot-dialog - save a hires screen shot

old-snapshot-dialog - save a screenshot

old-print-dialog - print the screen (Windows only)

old-pilot-offset-dialog - set pilot offsets graphically

old-hud-alpha-dialog - set the alpha value for the HUD

old-properties-dialog - display the property browser

old-preset-airport-dialog - set the default airport

old-preset-runway-dialog - set the default runway

old-preset-offset-distance-dialog - set the default offset distance

old-preset-altitude-dialog - set the default altitude

old-preset-glidescope-dialog - set the default glidescope

old-preset-airspeed-dialog - set the default airspeed

old-preset-commit-dialog - commit preset values

old-ap-add-waypoint-dialog - add a waypoint to the current route

old-ap-pop-waypoint-dialog - remove a waypoint from the current route
```

```
old-ap-clear-dialog - clear the current route

old-ap-adjust-dialog - adjust the autopilot settings

old-lat-lon-format-dialog - toggle the lat/lon format in the HUD


Adding New Commands in C++
--------------------------


To add a new command to FlightGear, you first need to create a
function that takes a single SGPropertyNode const pointer as an
argument:

  void
  do_something (SGPropertyNode * arg)
  {
    something();
  }

Next, you need to register it with the command manager:

  globals->get_commands()->addCommand("something", do_something);

Now, the command "something" is available to any mouse, joystick,
panel, or keyboard bindings.  If the bindings pass any arguments, they
will be children of the SGPropertyNode passed in:

  void
  do_something (const SGPropertyNode * arg)
  {
    something(arg->getStringValue("foo"), arg->getDoubleValue("bar"));
  }

That's pretty-much it.  Apologies in advance for not making things any
more complicated.
```

6 Conditions

CONDITIONS IN FLIGHTGEAR PROPERTY FILES

Written by David Megginson, david@megginson.com
Last modified: $Date$

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1. Introduction

Some FlightGear property files contain conditions, affecting whether bindings or animations are applied. For example, the following binding will apply only when the /sim/input/selected/engine[0] property is true:

```
  <binding>
   <condition>
    <property>/sim/input/selected/engine[0]</property>
   </condition>
   <command>property-assign</command>
   <property>/controls/starter[0]</property>
   <value type="bool">true</value>
  </binding>
```

Conditions always occur within a property subtree named "condition", which is equivalent to an "and" condition.

2. Comparison Operators

The simplest condition is "property". It resolves as true when the specified property has a boolean value of true (i.e. non-zero, etc.) and false otherwise. Here is an example:

```
  <condition>
   <property>/sim/input/selected/engine[0]</property>
```

```
  </condition>
```

For more sophisticated tests, you can use the "less-than", "less-than-equals", "greater-than", "greater-than-equals", "equals", and "not-equals" comparison operators. These all take two operands, either two "property" operands or one "property" and one "value" operand, and return true or false depending on the result of the comparison. The value of the second operand is always forced to the type of the first; for example, if you compare a string and a double, the double will be forced to a string and lexically compared. If one of the operands is a property, it is always assumed to be first. Here is an example of a comparison that is true only if the RPM of the engine is less than 1500:

```
  <condition>
   <less-than>
    <property>/engines/engine[0]/rpm</property>
    <value>1500</value>
   </less-than>
  </condition>
```

3. Boolean Operators

Finally, there are the regular boolean operators "and", "or", and "not". Each one surrounds a group of other conditions, and these can be nested to arbitrary depths. Here is an example:

```
  <condition>
   <and>
    <or>
     <less-than>
      <property>/engines/engine[0]/rpm</property>
      <value>1500</value>
     </less-than>
     <greater-than>
      <property>/engines/engine[0]/rpm</property>
      <value>2500</value>
     </greater-than>
```

```
    </or>
    <property>/engines/engine[0]/running</property>
   </and>
  </condition>

The top-level "condition" is an implicit "and".


4. Approximating if...else
--------------------------

There is no equivalent to the regular programming 'else' statement in
FlightGear conditions; instead, each condition separately must take
the others into account.  For example, the equivalent of

  if (x == 3) ... else if (y == 5) ... else ...

in FlightGear conditions is

  <condition>
   <equals>
    <property>/x</property>
    <value>3</value>
   </equals>
   <not>
    <equals>
     <property>/y</property>
     <value>5</value>
    </equals>
   </not>
  </condition>

and then

  <condition>
   <equals>
    <property>/y</property>
    <value>5</value>
   </equals>
   <not>
```

```
    <equals>
     <property>/x</property>
     <value>3</value>
    </equals>
   </not>
  </condition>
```

and then

```
  <condition>
   <not>
    <equals>
     <property>/x</property>
     <value>3</value>
    </equals>
   </not>
   <not>
    <equals>
     <property>/y</property>
     <value>5</value>
    </equals>
   </not>
  </condition>
```

It's verbose, but it works nicely within existing property-based formats and provides a lot of flexiblity.

5. Syntax Summary

Here's a quick syntax summary:

* <and>...</and>

  Contains one or more subconditions, all of which must be true.

* <condition>...</condition>

  The top-level container for conditions, equivalent to an "and" group

* <equals>...</equals>

  Contains two properties or a property and value, and is true if the properties have equivalent values.

* <not-equals>...</not-equals>

  Contains two properties or a property and value, and is true if the properties have different values.

* <greater-than>...</greater-than>

  Contains two properties or a property and a value, and is true if the second property or the value has a value greater than the first property.

* <greater-than-equals>...</greater-than-equals>

  Contains two properties or a property and a value, and is true if the second property or the value has a value greater than or equal to the first property.

* <less-than>...</less-than>

  Contains two properties or a property and a value, and is true if the second property or the value has a value less than the first property.

* <less-than-equals>...</less-than-equals>

  Contains two properties or a property and a value, and is true if the second property or the value has a value less than or equal to the first property.

* <not>...</not>

  Contains one subcondition, which must not be true.

* <not-equals>...</not-equals>

Contains two properties or a property and value, and is true if the properties do not have equivalent values.

* <or>...</or>

  Contains one or more subconditions, at least one of which must be true.

* <property>...</property>

  The name of a property to test.

* <value>...</value>

  A literal value in a comparison.

7 Digitalfilters

COMMON SETTINGS
==========

Currently four types of digital filter implementations are supported. They all serve an individual purpose or are individual implementations of a specific filter type. Each filter implementation uses the same set of basic configuration tags and individual configuration elements. These individual elements are described in the section of the filter.

The InputValue
==========
Each filter has several driving values, like the input value itself, sometimes a reference value, a gain value and others. Most of these input values can be either a constant value or the value of a property. They all use the same syntax and will be referred to as InputValue in the remaining document.

The complete XML syntax for a InputValue is

<some-element>
  <condition>

```
    <!-- any condition as defined in README.conditions -->
  </condition>
  <property>/some/property/name</property>
  <value>0.0</value>
  <scale>1.0</value>
  <offset>0.0</offset>
  <max>infinity</max>
  <min>-infinity<min>
  <abs>false</abs>
  <period>
    <min>-180.0</min>
    <max>-180.0</max>
  </period>
</some-element>
```

The enclosing element <some-element> is the element defined in each filter, like <input>, <u_min>, <reference> etc. These elements will be described later.
The value of the input is calculated based on the given value, scale and offset as value * scale + offset
and the result is clipped to min/max, if given.
With the full set of given elements, the InputValue will initialize the named property to the value given, reduced by the given offset and reverse scaled by the given scale.

Example:

```
<input>
  <property>/controls/flight/rudder</property>
  <value>0.0</value>
  <scale>0.5</scale>
  <offset>0.5</offset>
</input>
```

Will use the property /controls/flight/rudder as the input of the filter. The property will be initialized at a value of zero and since the property usually is in the range [-1..+1], the the value of <input> will be in the range (-1)*0.5+0.5 to (+1)*0.5+0.5 which is [0..1].

The default values for elements not given are:
<value/> : 0.0
<scale/> : 1.0

```
<offset/>: 0.0
<property/> : none
<min/>   : unclipped
<max/>   : unclipped
<abs/>   : false

Some examples:
<input>
  <property>/position/altitude-ft</property>
  <scale>0.3048</scale>
</input>
Gives the altitude in meters. No initialization of the property is performed, no
offset applied.

<reference>
  <value>0.0</value>
</reference>
A constant reference of zero.

A abbreviated method of defining values exist for using a just constant or a
property. The above example may be written as
<reference>0.0</reference>
Or if the reference is defined in a property
<reference>/some/property/name</reference>
No initialization, scaling or offsetting is performed here.
The logic behind this is: If the text node in the element (the text between the
opening and closing tag) can be converted to a double value, it will be interpreted
as a double value. Otherwise the text will
be interpreted as a property name.
Examples:
<reference>3.1415927</reference>             - The constant of PI (roughly)
<reference>/position/altitude-ft</reference> - The property /position/altitude-ft
<reference>3kings</reference>                - The constant 3. The word kings is
                                               ignored
<reference>food4less</reference>             - The property food4less

The <property> element may also be written as <prop> for backward compatibility.

There may be one or more InputValues for the same input of a filter which may be
bound to conditions. Each InputValue will have its condition checked in the order
```

```
of InputValues given in the configuration file. The first InputValue that returns
true for its condition will be evaluated. Chaining a number of InputValues with
conditions and an unconditioned InputValue works like the C language equivalent
if( condition ) {
  // compute value of first element
} else if( condition2 ) {
  // compute value of second element
} else if( condition3 ) {
  // compute value of third element
} else {
  // compute value of last element
}

Example: Set the gain to 3.0 if /autopilot/locks/heading equals dg-heading-hold or
2.0 otherwise.
<digital-filter>
  <gain>
    <condition>
      <equals>
        <property>/autopilot/locks/heading</property>
        <value>dg-heading-hold</value>
      </equals>
    </condition>
    <value>3.0</value>
  <gain>
  <!-- Hint: omit a condition here as a fallthru else condition -->
  </gain>
    <value>2.0</value>
  <gain>
<digital-filter>

If the element <abs> is used and set to the value "true", only the absolute
value of the input (the positive part) is used for further computations. The
abs function is applied after all other computations are completed.

OutputValue
================================================================================
Each filter drives one to many output properties. No scaling or offsetting is
implemented for the output value, these should be done in the filter itself.
The output properties are defined in the <output/> element by adding <property/>
```

```
elements within the <output/> element. For just a single output property, the
<property/> element may be ommited. For backward compatibility, <property/> may
be replaced by <prop/>.  Non-existing properties will be created with type double.

Example: (Multiple output properties)
<output>
  <property>/some/output/property</property>
  <property>/some/other/output/property</property>
  <property>/and/another/output/property</property>
</output>

Example: a single output property
<output>/just/a/single/property</output>

Other Common Settings
================================================================================
<name>        String      The name of the filter. Used for debug purpose.
Example:
<name>pressure rate filter</name>

<debug>       Boolean     If true, this filter puts out debug information when
                          updated. Example: <debug>false</debug>

<input>       InputValue  The input property driving the filter.
                          Refer to InputValue for details.

<reference>   InputValue  The reference property for filter that need one.
                          Refer to InputValue for details.

<output>      Complex     Each filter can drive one to many output properties.
                          Refer to OutputValue for details.

<u_min>       InputValue  This defines the optional minimum and maximum value the
<u_max>                   output is clamped to. If neither <u_min> nor <u_max>
                          exists, the output is only limited by the internal limit
                          of double precision float computation.  If either <u_min>
                          or <u_max> is given, clamping is activated. A missing min
                          or max value defaults to 0 (zero).
                          Note: <u_min> and <u_max> may also occour within a <config>
                          element. <min> and <max> may be used as a substitude for
```

```
                        the corresponding u_xxx element.
<period>      Complex   Define a periodical input or output value. The phase width
                        is defined by the child elements <min> and <max> which are
                        of type InputValue

Example: Limit the pilot's body temperature to a constant minimum of 36 and a
maximum defined in /pilots/max-body-temperature-degc, initialized to 40.0
<u_max>
  <prop>/pilots/max-body-temperature-degc</prop>
  <value>40.0</
</u_max>
<min>
  <value>36.0</value>
</min

Implicit definition of the minimum value of 0 (zero) and defining a maximum of 100.0
<config>
  <u_max>100.0</u_max>
</config>

This defines the input or output as a periodic value with a phase width of 360, like
the compass rose.  Any value reaching the filter's input or leaving the filter at the
output will be transformed to fit into the given range by adding or substracting one
phase width of 360. Values of -270, 90 or 450 applied to this periodical element will
always result in +90. A value of 630, 270 or -90 will be normalized to -90 in the
given example.
<period>
  <min>-180.0</min>
  <max>180.0</max>
</period>


<enable>      Complex   Define a condition to enable or disable the filter. For
                        disabled filters, no output computations are performed.
                        Only enabled filters fill the output properties. The
                        default for undefined conditions is enabled.
                        Several way exist to define a condition. The most simple
                        case is checking a boolean property. For this, just a
                        <prop> element naming this boolean property is needed.
                        The boolean value of the named property defines the
```

```
                        enabled state of the filter. To compare the value of a
                        property with a constant, a <prop> and a <value> element
                        define the property name and the value to be compared.
                        The filter is enabled, if the value of the property equals
                        the given value. A case sensitive string compare is
                        performed here.
                        To define more complex conditions, a <condition> element
                        may be used to define any condition described in
                        README.conditions.  If a <condition> element is present
                        and if it contains a valid condition, this conditions has
                        precedence over a given <prop>/<value> condition.
                        The child element <honor-passive>, a boolean flag, may be
                        present within the <enable> element. If this element is
                        true, the property /autopilot/locks/passive-mode is checked
                        and if it is true, the filter output is computed, but the
                        output properties are not set.  The default for
                        honor-passive is false
Example: Check a boolean property, only compute this filter if gear-down is true and
         /autopilot/locks/passive-mode is false
<enable>
  <prop>/gear/gear-down</prop>
  <honor-passive>true</honor-passive>
</enable>

Check a property for equality, only compute this filter if the autopilot is locked
in heading mode.
<enable>
  <prop>/autopilot/locks/heading</prop>
  <value>dg-heading-hold</value>
</enable>

Use a complex condition, only compute this filter if the autopilot is serviceable
and the lock is either dg-heading-hold or nav1-heading-hold
<enable>
  <condition>
    <property>/autopilo/serviceable</property>
    <or>
      <equals>
        <property>/autopilot/locks/heading</property>
        <value>dg-heading-hold</value>
```

```
      </equals>
      <equals>
        <property>/autopilot/locks/heading</property>
        <value>nav1-heading-hold</value>
      </equals>
    </or>
  </condition>
</enable>
```

INDIVIDUAL FILTER CONFIGURATION
==========

Digital Filter

Six different types of digital filter can be configured inside the autopilot configuration file. There are four low-pass filter types and two gain filter types.

The low-pass filter types are:

* Exponential
* Double exponential
* Moving average
* Noise spike filter

The gain filter types are:

* gain
* reciprocal

To add a digital filter, place a <filter> element under the root element. Next to the global configuration elements described above, the following elements configure the digital filter:

<filter-time>	InputValue	This tag is only applicable for the exponential and double-exponential filter types. It controls the bandwidth of the filter. The bandwidth in Hz of the filter is: 1/filter-time. So a low-pass filter with a bandwidth of 10Hz would have a filter time of 1/10 = 0.1
<samples>	InputValue	This tag only makes sense for the moving-average filter.

```
                          It says how many past samples to average.

<max-rate-of-change>
              InputValue  This tag is applicable for the noise-spike filter.
                          It says how much the value is allowed to change per
                          second.

<gain>        InputValue  This is only applicable to the gain and reciprocal filter
                          types. The output for gain filter is computed as input*gain
                          while  the reciprocal filter computes output as gain/input
                          for input values != 0 (zero). Gain may be a constant, a
                          property name defined by a <prop> element within the <gain>
                          element or a  property name initialized to a value by using
                          a <prop> and <value> element.

Example: a pressure-rate-filter implemented as a double exponential low pass filter
         with a bandwith of 10Hz

  <filter>
    <name>pressure-rate-filter</name>
    <debug>false</debug>
    <type>double-exponential</type>
    <enable>
      <prop>/autopilot/locks/pressure-rate-filter</prop>
      <value>true</value>
    </enable>
    <input>/autopilot/internal/pressure-rate</input>
    <output>/autopilot/internal/filtered-pressure-rate</output>
    <filter-time>0.1</filter-time>
  </filter>

This will filter the pressure-rate property. The output will be to a new
property called filtered-pressure-rate. You can select any numerical property
from the property tree. The input property will not be affected by the filter,
it will stay the same as it would if no filter was configured.

Example 2:

  <filter>
    <name>airspeed elevator-trim gain reciprocal filter</name>
```

```
    <debug>false</debug>
    <enable>
      <prop>/autopilot/locks/airspeed-elevator-trim-gain</prop>
      <value>true</value>
    </enable>
    <type>reciprocal</type>
    <gain>
      <prop>/autopilot/settings/elevator-trim-airspeed-reciprocal-gain</prop>
      <value>7</value>
    </gain>
    <input>/velocities/airspeed-kt</input>
    <output>/autopilot/internal/elevator-trim-gain</output>
    <u_min>0.005</u_min>
    <u_max>0.02</u_max>
  </filter>
```

This will use the /velocities/airspeed-kt property to produce a gain factor that reduces as airspeed increases. At airspeeds up to 350kt the gain will be clamped to 0.02, at 700kt the gain will be 0.01 and at 1400kt the gain will be 0.005. The gain will be clamped to 0.005 for airspeeds > 1400kt.

The output from this filter could then be used to control the gain in a PID controller:

```
  <pid-controller>
    <name>Pitch hold</name>
    <debug>false</debug>
    <enable>
      <prop>/autopilot/locks/pitch</prop>
      <value>true</value>
    </enable>
    <input>
      <prop>/orientation/pitch-deg</prop>
    </input>
    <reference>
      <prop>/autopilot/settings/target-pitch-deg</prop>
    </reference>
    <output>
      <prop>/autopilot/internal/target-elevator-trim-norm</prop>
    </output>
```

```
    <config>
      <Ts>0.05</Ts>
      <Kp>
        <prop>/autopilot/internal/elevator-trim-gain</prop>
        <value>0.02</value>
      </Kp>
      <beta>1.0</beta>
      <alpha>0.1</alpha>
      <gamma>0.0</gamma>
      <Ti>2.0</Ti>
      <Td>0.2</Td>
      <u_min>-1.0</u_min>
      <u_max>1.0</u_max>
    </config>
  </pid-controller>
```

IMPORTANT NOTE: The <Kp> tag in PID controllers has been revised to operate in the same way as the <gain> elements in filters. However, the original format of <Kp> will continue to function as before i.e. <Kp>0.02</Kp> will specify a fixed and unalterable gain factor, but a warning message will be output.

The gain type filter is similar to the reciprocal filter except that the gain is applied as a simple factor to the input.

Parameters

<name> The name of the filter. Give it a sensible name!

<debug> If this tag is set to true debugging info will be printed on the console.

<enable> Encloses the <prop> and <value> tags which are used to enable or disable the filter. Instead of the <prop> and <value> tags, a <condition> tag may be used to define a condition. Check README.conditions for more details about conditions. Defaults to enabled if unspecified.

<type> The type of filter. This can be exponential, double-exponential, moving-average, noise-spike, gain or reciprocal.

<input> The input property to be filtered. This should of course be a

numerical property, filtering a text string or a boolean value does not make sense.

<output> The filtered value. You can make up any new property.

<u_min> The minimum output value from the filter. Defaults to -infinity.

<u_max> The maximum output value from the filter. Defaults to +infinity.

These are the tags that are applicable to all filter types. The following tags are filter specific.

<filter-time> This tag is only applicable for the exponential and double-exponential filter types. It controls the bandwidth of the filter. The bandwidth in Hz of the filter is: 1/filter-time. So a low-pass filter with a bandwidth of 10Hz would have a filter time of 1/10 = 0.1

<samples> This tag only makes sense for the moving-average filter. It says how many past samples to average.

<max-rate-of-change> This tag is applicable for the noise-spike filter. Is says how much the value is allowed to change per second.

<gain> This, and it's enclosed <prop> and <value> tags, are only applicable to the gain and reciprocal filter types. The <prop> tag specifies a property node to hold the gain value and the <value> tag specifies an initial default value. The gain defaults to 1.0 if unspecified.

The output from the gain filter type is: input * gain.
The output from the reciprocal filter type is: gain / input.

The gain can be changed during run-time by updating the value in the property node.

8 Effects

Effects

Effects describe the graphical appearance of 3d objects and scenery in FlightGear. The main motivation for effects is to support OpenGL shaders and to provide different implementations for graphics hardware of varying capabilities. Effects are similar to DirectX effects files and Ogre3D material scripts.

An effect is a property list. The property list syntax is extended with new "vec3d" and "vec4d" types to support common computer graphics values. Effects are read from files with a ".eff" extension or can be created on-the-fly by FlightGear at runtime. An effect consists of a "parameters" section followed by "technique" descriptions. The "parameters" section is a tree of values that describe, abstractly, the graphical characteristics of objects that use the effect. Techniques refer to these parameters and use them to set OpenGL state or to set parameters for shader programs. The names of properties in the parameter section can be whatever the effects author chooses, although some standard parameters are set by FlightGear itself. On the other hand, the properties in the techniques section are all defined by the FlightGear.

Techniques

A technique can contain a predicate that describes the OpenGL functionality required to support the technique. The first technique with a valid predicate in the list of techniques is used to set up the graphics state of the effect. A technique with no predicate is always assumed to be valid. The predicate is written in a little expression language that supports the following primitives:

and, or, equal, less, less-equal
glversion - returns the version number of OpenGL
extension-supported - returns true if an OpenGL extension is supported
property - returns the boolean value of a property
float-property - returns the float value of a property, useful inside equal, less
or less-equal nodes
shader-language - returns the version of GLSL supported, or 0 if there is none.

The proper way to test whether to enable a shader-based technique is:
<predicate>

```
    <and>
    <property>/sim/rendering/shader-effects</property>
    <less-equal>
      <value type="float">1.0</value>
      <shader-language/>
    </less-equal>
    </and>
  </predicate>
```

There is also a property set by the user to indicate what is the level of quality desired. This level of quality can be checked in the predicate like this :

```
    <predicate>
      <and>
        <property>/sim/rendering/shader-effects</property>
  <less-equal>
    <value type="float">2.0</value>
    <float-property>/sim/rendering/quality-level</float-property>
  </less-equal>
  <!-- other predicate conditions -->
      </and>
    </predicate>
```

The range of /sim/rendering/quality-level is [0..5]
 * 2.0 is the threshold for relief mapping effects,
 * 4.0 is the threshold for geometry shader usage.

A technique can consist of several passes. A pass is basically an Open Scene Graph StateSet. Ultimately all OpenGL and OSG modes and state attributes will be accessable in techniques. State attributes -- that is, technique properties that have children and are not just boolean modes -- have an <active> parameter which enables or disables the attribute. In this way a technique can declare parameters it needs, but not enable the attribute at all if it is not needed; the decision can be based on a parameter in the parameters section of the effect. For example, effects that support transparent and opaque geometry could have as part of a technique:

```
    <blend>
    <active><use>blend/active</use></active>
```

```
    <source>src-alpha</source>
    <destination>one-minus-src-alpha</destination>
    </blend>

So if the blend/active parameter is true blending will be activated
using the usual blending equation; otherwise blending is disabled.

Values of Technique Attributes
------------------------------

Values are assigned to technique properties in several ways:

  * They can appear directly in the techniques section as a
    constant. For example:
    <uniform>
      <name>ColorsTex</name>
      <type>sampler-1d</type>
      <value type="int">2</value>
    </uniform>
    * The name of a property in the parameters section can be
    referenced using a "use" clause. For example, in the technique
    section:
    <material>
      <ambient><use>material/ambient</use></ambient>
    </material>
    Then, in the parameters section of the effect:
    <parameters>
      <material>
        <ambient type="vec4d">0.2 0.2 0.2 1.0</ambient>
      </material>
    </parameters>

    It's worth pointing out that the "material" property in a
    technique specifies part of OpenGL's state, whereas "material"
    in the parameters section is just a name, part of a
    hierarchical namespace.

    * A property in the parameters section doesn't need to contain
    a constant value; it can also contain a "use" property. Here
    the value of the use clause is the name of a node in an
```

```
    external property tree which will be used as the source of a
    value. If the name begins with '/', the node is in
    FlightGear's global property tree; otherwise, it is in a local
    property tree, usually belonging to a model [NOT IMPLEMENTED
    YET]. For example:
    <parameters>
      <chrome-light><use>/rendering/scene/chrome-light</use></chrome-light>
    </parameters>
    The type is determined by what is expected by the technique
    attribute that will ultimately receive the value. [There is
    no way to get vector values out of the main property system
    yet; this will be fixed shortly.] Values that are declared
    this way are dynamically updated if the property node
    changes.

OpenGL Attributes
-----------------

The following attributes are currently implemented in techiques:
alpha-test - children: active, comparison, reference
     Valid values for comparision:
       never, less, equal, lequal, greater, notequal, gequal,
       always

alpha-to-coverage - true, false

blend - children: active, source, destination, source-rgb,
     source-alpha, destination-rgb, destination-alpha
     Each operand can have the following values:
       dst-alpha, dst-color, one, one-minus-dst-alpha,
       one-minus-dst-color, one-minus-src-alpha,
       one-minus-src-color, src-alpha, src-alpha-saturate,
       src-color, constant-color, one-minus-constant-color,
       constant-alpha, one-minus-constant-alpha, zero

cull-face - front, back, front-back

lighting - true, false

material - children: active, ambient, ambient-front, ambient-back, diffuse,
```

```
     diffuse-front, diffuse-back, specular, specular-front,
     specular-back, emissive, emissive-front, emissive-back, shininess,
     shininess-front, shininess-back, color-mode

polygon-mode - children: front, back
    Valid values:
        fill, line, point

program
    vertex-shader
    geometry-shader
    fragment-shader
    attribute
    geometry-vertices-out - integer, max number of vertices emitted by geometry
                            shader
    geometry-input-type - points, lines, lines-adjacency, triangles,
                          triangles-adjacency
    geometry-output-type - points, line-strip, triangle-strip

render-bin - (OSG) children: bin-number, bin-name

rendering-hint - (OSG) opaque, transparent

shade-model - flat, smooth

texture-unit - has several child properties:
  unit - The number of an OpenGL texture unit
    type - This is either an OpenGL texture type or the name of a
    builtin texture. Currently supported OpenGL types are 1d, 2d,
    3d which have the following common parameters:
    image (file name)
      filter
      mag-filter
      wrap-s
      wrap-t
      wrap-r
    The following built-in types are supported:
      white - 1 pixel white texture
      noise - a 3d noise texture
    environment
```

```
      mode
      color
uniform
    name
    type - float, float-vec3, float-vec4, sampler-1d, sampler-2d,
    sampler-3d

vertex-program-two-side - true, false

vertex-program-point-size - true, false
```

Inheritance

One feature not fully illustrated in the sample below is that effects can inherit from each other. The parent effect is listed in the "inherits-from" form. The child effect's property tree is overlaid over that of the parent. Nodes that have the same name and property index -- set by the "n=" attribute in the property tag -- are recursively merged. Leaf property nodes from the child have precedence. This means that effects that inherit from the example effect below could be very short, listing just new parameters and adding nothing to the techniques section; alternatively, a technique could be altered or customized in a child, listing (for example) a different shader program. An example showing inheritance Effects/crop.eff, which inherits some if its values from Effects/terrain-default.eff.

FlightGear directly uses effects inheritance to assign effects to 3D models and terrain. As described below, at runtime small effects are created that contain material and texture values in a "parameters" section. These effects inherit from another effect which references those parameters in its "techniques" section. The derived effect overrides any default values that might be in the base effect's parameters section.

Generate

Often shader effects need tangent vectors to work properly. These

tangent vectors, usually called tangent and binormal, are computed on the CPU and given to the shader as vertex attributes. These vectors are computed on demand on the geometry using the effect if the 'generate' clause is present in the effect file. Exemple :

```
  <generate>
    <tangent type="int">6</tangent>
    <binormal type="int">7</binormal>
    <normal type="int">8</normal>
  </generate>
```

Valid subnodes of 'generate' are 'tangent', 'binormal' or 'normal'. The integer value of these subnode is the index of the attribute that will hold the value of the vec3 vector.

The generate clause is located under PropertyList in the xml file.

In order to be available for the vertex shader, these data should be bound to an attribute in the program clause, like this :

```
  <program>
    <vertex-shader>my_vertex_shader</vertex-shader>
    <attribute>
      <name>my_tangent_attribute</name>
      <index>6</index>
    </attribute>
    <attribute>
      <name>my_binormal_attribute</name>
      <index>7</index>
    </attribute>
  </program>
```

attribute names are whatever the shader use. The index is the one declared in the 'generate' clause. So because generate/tangent has value 6 and my_tangent_attribute has index 6, my_tangent_attribute holds the tangent value for the vertex.

Default Effects in Terrain Materials and Models

Effects for terrain work in this way: for each material type in materials.xml an effect is created that inherits from a single default terrain effect, Effects/terrain-default.eff. The parameters section of the effect is filled in using the ambient, diffuse, specular, emissive, shininess, and transparent fields of the material. The parameters image, filter, wrap-s, and wrap-t are also initialized from the material xml. Seperate effects are created for each texture variant of a material.

Model effects are created by walking the OpenSceneGraph scene graph for a model and replacing nodes (osg::Geode) that have state sets with node that uses an effect instead. Again, a small effect is created with parameters extracted from OSG objects; this effect inherits, by default, from Effects/model-default.eff. A larger set of parameters is created for model effects than for terrain because there is more variation possible from the OSG model loaders than from the terrain system. The parameters created are:

  * material active, ambient, diffuse, specular, emissive, shininess, color mode
    * blend active, source, destination
    * shade-model
    * cull-face
  * rendering-hint
  * texture type, image, filter, wrap-s, wrap-t

Specifying Custom Effects

You can specify the effects that will be used by FlightGear as the base effect when it creates terrain and model effects.

In the terrain materials.xml, an "effect" property specifies the name of the model to use.

In model .xml files, A richer syntax is supported. [TO BE DETERMINED]

Material animations will be implemented by creating a new effect that inherits from one in a model, overriding the parameters that will be animated.

Examples

The Effects directory contains the effects definitions; look there for
examples. Effects/crop.eff is a good example of a complex effect.

Application

To apply an effect to a model or part of a model use:

```
  <effect>
    <inherits-from>Effects/light-cone</inherits-from>
    <object-name>Cone</object-name>
  </effect>
```

where <inherits-from> </inherits-from> contains the path to the effect you want to
apply. The effect does not need the file extension.

NOTE:

Chrome, although now implemented as an effect, still retains the old method of
application:

```
  <animation>
      <type>shader</type>
      <shader>chrome</shader>
      <texture>glass_shader.png</texture>
      <object-name>windscreen</object-name>
  </animation>
```

in order to maintain backward compatibility.

9 Electrical

Specifying and Configuring and Aircraft Electrical System
==========

Written by Curtis L. Olson <curt@flightgear.org>

February 3, 2003 - Initial revision.

Introduction

The FlightGear electrical system model is an approximation. We don't model down to the level of individual electrons, but we do try to model a rich enough subset of components so that a realistic (from the pilot's perspective) electrical system may be implemented. We try to model enough of the general flow so that typical electrical system failures can be implimented and so that the pilot can practice realistic troubleshooting techniques and learn the basic structure and relationships of the real aircraft electrical system.

An electrical system can be built from 4 major components: suppliers, buses, outputs, and connectors. Suppliers are things like batteries and generators. Buses collect input from multiple suppliers and feed multiple outputs. Outputs are not strictly necessary, but are included so we can name generic output types and provide a consistent naming scheme to other FlightGear subsystems. Finally connectors connect a supplier to a bus, or a bus to an output, and optionally can specify a switch property (either a physical switch or a circuit breaker.)

At run time, the structure specified in the electrical system config file is parsed and a directional graph (in the computer science sense) is built. Each frame, the current is propagated through the system, starting at the suppliers, flowing through the buses, and finally to the outputs. The system follows the path of connectors laid out in the config file and honors the state of any connector switch.

Suppliers

A supplier entry could look like the following:

```
  <supplier>
    <name>Battery 1</name>
    <prop>/systems/electrical/suppliers/battery[0]</prop>
    <kind>battery</kind>
    <volts>24</volts>
    <amps>60</amps>   <!-- WAG -->
  </supplier>

<name> can be anything you choose to call this entry.
<prop> is the name of a property that will be updated with the state
       of this supplier.
<kind> can be "battery", "alternator", or "external".
<volts> specifies the volts of the source
<amps> specifies the amps of the source

Currently <volts> and <amps> are not really modeled in detail.  This
is more of a place holder for the future.

For alternators, you must additionally specify:

    <rpm-source>/engines/engine[0]/rpm</rpm-source>

The value of the rpm source determines if the generator is able to
produce power or not.


Buses
=====

A bus entry could look like the following:

  <bus>
    <name>Essential/Cross Feed Bus</name>
    <prop>/systems/electrical/outputs/bus-essential</prop>
    <prop>/systems/electrical/outputs/annunciators</prop>
    <prop>/systems/electrical/outputs/master-switch</prop>
  </bus>

<name> is whatever you choose to call this bus
```

You can have an arbitrary number of <prop> entries. Each entry is the name of a property that will be updated with the value of the current at that bus. This allows you to wire devices directly to the bus but does not allow you to insert a switch or circuit breaker in between. See "Outputs" and "Connectors" if you want to do that.

Outputs
=======

An output entry could look like the following:

```
  <output>
    <name>Starter 1 Power</name>
    <prop>/systems/electrical/outputs/starter[0]</prop>
  </output>
```

An output isn't entirely unlike a bus, but it's nice conceptually to have a separate entity type. This enables us to specify a common set of output property names so that other subsystems can automatically work with any electrical system that follows the same conventions. An output lives on the other side of a switch, so this is how you can wire in cockpit switches to model things like fuel pump power, avionics master switch, or any other switch on the panel.

<name> is whatever you choose to call this bus

You can have an arbitrary number of <prop> entries. Each entry is the name of a property that will be updated with the value of the current at that bus. This allows you to wire devices directly to the bus but does not allow you to insert a switch or circuit breaker in between. See "Outputs" and "Connectors" if you want to do that.

Other FlightGear subsystems can monitor the property name associated with the various outputs to decide how to render an instrument, whether to run the fuel pump, whether to spin a gyro, or any other subsystem that cares about electrical power.

Connectors
==========

An connector entry could look like the following:

```
  <connector>
    <input>Alternator 1</input>
    <output>Virtual Bus 1</output>
    <switch>/controls/switches/master-alt</switch>
    <initial-state>off</initial-state>  <!-- optional tag -->
  </connector>
```

A connector specifies and input, and output, and any number of switches that are wired in series. In other words, all switches need to be true/on in order for current to get from the input to the output of the connector.

<input> specifies the <name> of the input. Typically you would specify a "supplier" or a "bus".

<output> specifies the <name> of the output. Typically you would specify a bus or an output.

You can have an arbitrary number of <switch> entries. The switches are wired in series so all of them need to be on (i.e. true) in order for current to pass to the output.

Note: by default the system forces any listed switches to be true. The assumption is that not every aircraft or cockpit may impliment every available switch, so rather than having systems be switched off, with no way to turn them on, we default to switched on.

This is a problem however with the starter switch which we want to be initialized to "off". To solve this problem you can specify <initial-state>off</initial-state> or <initial-state>on</initial-state> Switches default to on, so you really only need to specify this tag if you want the connector's switch to default to off.

Summary
=======

The electrical system has a lot of power and flexibility to model a variety of electrical systems. However, it is not yet perfect or finished. One major weakness is that it doesn't yet model degraded battery or generator power, and it doesn't model the "charge" of the batteries in case of a generator failure.

10 Fgjs

fgjs -- a small program for creating a basic FlightGear joystick configuration

fgjs requires plib to be installed on your system. If you've successfully installed and built FlightGear then you should be all set

Build instructions
At this point, fgjs has only been built and tested under Linux, so the makefile is a simple one. cd into the directory in which the fgjs source resides and type 'make' and, if you are lucky, all will go well. You can e-mail me (apeden@earthlink.net) any changes needed to make it work on other systems. It's quite possible that this program will become part of the regular FlightGear package so

Running
Set up your joystick and make sure it works with js_demo from the FlightGear distribution. Upon executing fgjs, it will prompt you to move the control you wish to use for elevator, ailerons, etc. Note that when being prompted for an analog control, you can skip the current one by pressing any button and vice-versa when being prompted for a button. You may want to do this if for, as an example, rudder if you have only one joystick or your joystick doesn't have as many analog axes as FlightGear supports.

Once you've run with this configuration, you may wish to tune the dead-band a bit (see fgfsrc.js) as the default, 0.02, may

be too narrow for your particular hardware/taste.

And last, but not least, this thing needs a GUI!!!! Hopefully,
the joystick handling code and interface code are separate
enough that using that a GUI version could be built using this
source as a starting point.

11 Flightrecorder

FlightGear Flight Recorder Mini-HOWTO

Thorsten Brehm
Started in August 2011
Last revised: 2011-09-26

FlightGear provides a customizable flight recorder capable of capturing
any selection of properties described via XML configuration files.
The recorder is currently used for the replay system.

Feature Brief
----
* Generic recording system, adaptable to any aircraft/data, provided that
  data is accessible via the property tree. No hard-coded selections or
  assumptions on properties to be recorded.
* Configuration read from XML files or the property tree itself.
* Interpolation method configurable per recorded/replayed signal.

```
* Adaptable recording resolution per signal.
* Multiple configurations supported.


Quick Start: Basic Configuration
--------------------------------
To configure and adapt the flight recorder, add a "/sim/flight-recorder"
section to your aircraft -set.xml file.

Example:

<sim>

  <!-- ... -->

  <flight-recorder>
    <replay-config type="int">0</replay-config>
    <config n="0"
        include="/Aircraft/Generic/flightrecorder/generic-piston-propeller-1.xml">
      <name type="string">My Aircraft's Flight Recorder</name>
      <!-- Custom properties -->
      <signal>
        <type>float</type>
        <property type="string">/controls/gear/nosegear-steering-cmd-norm</property>
        <interpolation>linear</interpolation>
      </signal>
      <!-- More custom signals here -->
    </config>
  </flight-recorder>

      <!-- ... -->

</sim>

Default type for each signal is "float". Default "interpolation" method
is "linear" (for float/double). Default values may be omitted. See
configuration details below.


Generic Configuration Files
```

```
---------------------------
Select one of the default configuration files to specify the basic
properties to be recorded. It's not recommended to specify all
properties to be recorded individually.
The following generic files are provided:

* /Aircraft/Generic/flightrecorder/generic-piston-propeller-4.xml
  Matches propeller aircraft with 4 piston engines, 4 tanks,
  3 retractable gear.
  It is the same configuration that was hard-coded for the replay system
  up to FlightGear 2.4.0. To provide backward compatibility this
  configuration is loaded by default, unless an aircraft provides a
  specific flight recorder configuration.

* /Aircraft/Generic/flightrecorder/generic-piston-propeller-1.xml
  Matches propeller aircraft with 1 piston engines, 2 tanks, 3 fixed
  gear.

* /Aircraft/Generic/flightrecorder/generic-turboprop-2.xml
  Matches turboprop aircraft with 2 turbines/propellers, 4 tanks,
  3 retractable gear.

* /Aircraft/Generic/flightrecorder/generic-jet.xml
  Matches jet aircraft with 2 jet engines, 4 tanks.

* /Aircraft/Generic/flightrecorder/generic-glider.xml
  Matches gliders (no engines, no tanks, single fixed gear).

* /Aircraft/Generic/flightrecorder/generic-helicopter.xml
  Matches helicopters with main and tail rotor (tested with YASim).

If none of the generic files matches your aircraft, simply use a
configuration which covers more than you need. Alternatively, copy the
contents of one of these generic files to your aircraft, and adapt as
needed (see below).

FDM experts are welcome to add more generic configuration files to
/Aircraft/Generic/flightrecorder - such as YASim-/JSBSim-specific
configurations, and configurations for other types of aircraft
(balloons, airships, ...).
```

```
Generic Components
------------------
The generic configuration files in turn include a set of generic
components. If you copy the contents of a generic file to your aircraft,
you can adapt the components to your needs. See examples.
It is not recommended to copy the contents of the _component_ files to
an aircraft though (causes too much hassle and dependencies).

Engine Selection:
 * /Aircraft/Generic/flightrecorder/components/engine-jet.xml
   Records properties of a single jet engine.
   For multiple jet engines, use "count". Example for 4 jets:
     <signals include="/Aircraft/Generic/flightrecorder/components/engine-jet.xml">
       <count>4</count>
     </signals>

 * /Aircraft/Generic/flightrecorder/components/engine-piston.xml
   Records properties of a single piston engine and propeller.
   For multiple piston engines, use "count" (see "jet" example).

 * /Aircraft/Generic/flightrecorder/components/rotor.xml
   Records properties of a single helicopter rotor (tested with YASim).
   To use this, provide the base property path to the rotor as "prefix".
   Example recording the rotor below "/rotors/main":
     <signals include="/Aircraft/Generic/flightrecorder/components/rotor.xml">
         <prefix type="string">/rotors/main</prefix>
     </signals>

Gear Selection:
 * /Aircraft/Generic/flightrecorder/components/gear-fixed.xml
   Records properties of a single non-retractable gear.
   For multiple fixed gear, use "count" (see "jet" example).

 * /Aircraft/Generic/flightrecorder/components/gear-retractable.xml
   Records properties of a single retractable gear.
   For multiple retractable gear, use "count" (see "jet" example).

Tanks:
```

```
 * /Aircraft/Generic/flightrecorder/components/tanks.xml
   Records properties of a single fuel tank.
   For multiple fuel tanks, use "count" (see "jet" example).

Other:
 * /Aircraft/Generic/flightrecorder/components/surfaces.xml
   Records properties of flight control surfaces. Include this
   for aircraft (with wings). Not useful for helicopters,
   balloons, ...

 * /Aircraft/Generic/flightrecorder/components/faults-engines.xml
   Records fault properties of a single engine. Only include this
   if your aircraft supports fault simulation.
   For multiple engines, use "count" (see "jet" example). If used,
   it should be compined with piston or jet engine.

 * /Aircraft/Generic/flightrecorder/components/environment.xml
   Records properties of environment/weather (visibility,
   temperature - but _not_ cloud position...).

 * /Aircraft/Generic/flightrecorder/components/position.xml
   Records properties of a the aircrafts main position (latitude,
   longitude, velocities, ...).
   This is the most important component. Always include this.

 * /Aircraft/Generic/flightrecorder/components/controls.xml
   Records most important flight controls (rudder, aileron,
   elevator, ...). Always include this.


Custom Properties
-----------------
When the generic or component files are not be sufficient to record or
replay aircraft-specific effects, you can add custom properties (signals
to be recorded) to the configuration.
Each signal consits of a recording type/resolution (which does _not_
need to match the actual type in the property tree!), the path to the
property and interpolation type.

Example recording some additional custom properties:
```

```
  <sim>
    <flight-recorder>
      <config n="0"
        include="/Aircraft/Generic/flightrecorder/generic-piston-propeller-1.xml">
        <!-- Add custom properties here -->
        <signal>
          <type>float</type>
          <property type="string">/controls/gear/nosegear-steering-cmd-norm</property
        </signal>
        <signal>
          <type>double</type>
          <interpolation>rotational-deg</interpolation>
          <property type="string">/ai/model/carrier/alpha-angle-deg</property>
        </signal>
        <signal>
          <type>bool</type>
          <property type="string">/controls/panel/custom-switch</property>
        </signal>
      </config>
    </flight-recorder>
  </sim>


Signal Configuration
--------------------
Template:
  <signal>
    <type>bool</type>
    <interpolation>angular-deg</interpolation>
    <property type="string">/controls/panel/custom-switch</property>
  </signal>

* type: The signal's type specifies the recording resolution - not the
  type of the original property. The following types are supported:

  - double: 8 byte/sample
  - float:  4 byte/sample (default)
  - int:    4 byte/sample, integer
  - int16:  2 byte/sample, integer
  - int8:   1 byte/sample, integer
```

```
  - bool:   1 bit/sample (yes, 1 bit. 8 bools per byte).

  String type is unsupported (too expensive).

* interpolation: Specifies how values are interpolated during replay, i.e.
  when replay is in slow-motion mode and more frames/second are required
  than recorded, or when replaying data from the medium/long term memory.
  Supported methods:
    - discrete: No interpolation. Default for integer/bool types.
    - linear: Standard linear interpolation. Default for float/double.
    - angular-rad (or angular): Angular values in radians (0-2pi).
    - angular-deg: Angular values in degrees (0-360).

* property: Path to the property to be recorded.


Advanced Configuration
----------------------
- Multipe recorder configurations for a single aircraft are supported
  (multiple "<config n=..>" sections for n=0,1,...).
  Active configuration to be used for the replay system is selected via
     /sim/flight-recorder/replay-config (= 0,1,...).
  This can be useful for specific recorders for specific scenarios,
  which should not be used by default. For example, a specific recorder
  configuration could be provided which also records the position of
  an aircraft carrier, of other AI aircraft, ...
  This may also be useful for future use, i.e. to select another flight
  recorded configuration for a different purpose, such as for the
  multiplayer system.

- Flight recorder configuration can be adapted during run-time
  (configuration is visible in the property browser below
  /sim/flight-recorder). However it is necessary to reset (reinit) the
  replay subsystem first - which also erases earlier recordings. It is
  not possible to mix recordings of different configurations on to a
  single "tape".

- Each configuration should be given a name. Useful for a (future)
  selection GUI, when multiple configurations are available.
```

```
Optimizing Performance
----------------------
- Recording properties consumes memory and also CPU time. A few
  additional properties don't matter much, but avoid execessive numbers.
  Reduce the resolution (type) of signals to the minimum necessary to
  save space.
- Use "bool" types where possible, they are most efficient.
- Avoid recording with "double" resolution (type "double"). Use "float"
  instead - even if the original property in the property tree is a
  "double" (almost all of them do). "float" precision is almost always
  sufficient for recording/replay purposes, with few exceptions (like
  latitude/longitude properties).
- Use int16/int8 for "small" integer values.


Recording/Replay Limits
-----------------------
- All properties can be recorded, however, only writable properties can
  be replayed. Properties marked as read-only, or tied properties not
  implementing the "set" method cannot be replayed.
- Replaying a property overwrites the property's value. However, other
  sources may also write to the same property - such as Nasal code,
  autopilot rules etc. When multiple sources "fight" over a property's
  value then the last update "wins" - resulting in a dependency to an
  unknown/random sequence. Hence, during deplay, try to disable other
  sources writing to properties which were recorded and should be
  replayed.
  If the other source cannot be disabled, check if you're recording the
  right property. It may be better to record the input properties of the
  other source instead (i.e. the inputs processed by the Nasal or
  autopilot rule).

__end__
```

12 Gui

```
FlightGear GUI Mini-HOWTO
```

David Megginson
Started: 2003-01-20
Last revised: 2003-01-20

FlightGear creates its drop-down menubar and dialog boxes from XML configuration files under $FG_ROOT/gui. This document gives a quick explanation of how to create or modify the menubar and dialogs. The toolkit for the FlightGear GUI is PUI, which is part of plib.

All of the XML files use the standard FlightGear PropertyList format.

MENUBAR

FlightGear reads the configuration for its menubar from $FG_ROOT/gui/menubar.xml. The file consists of a series of top-level elements named "menu", each of which defines on of the drop-down menus, from left to right. Each menu contains a series of items, representing the actual items a user can select from the menu, and each item has a series of bindings that FlightGear will activate when the user selects the item.

Here's a simplified grammar:

```
  [menubar] : menu*

  menu : label, item*

  item : label, enabled, binding*
```

The bindings are standard FlightGear bindings, the same as the ones used for the keyboard, mouse, joysticks, and the instrument panel. Any commands allowed in those bindings are allowed here as well.

Here's an example of a simple menubar with a "File" drop-down menu and a single "Quit" item:

```
  <PropertyList>

   <menu>
    <label>File</label>

    <item>
     <label>Quit</label>
     <binding>
      <command>exit</command>
     </binding>
    </item>

  </PropertyList>
```

PUI menus do not allow advanced features like submenus or checkmarks. The most common command to include in a menu item binding is the 'dialog-show' command, which will open a user-defined dialog box as described in the next section.

DIALOGS

The configuration files for XML dialogs use a nested structure to set up dialog boxes. The top-level always describes a dialog box, and the lower levels describe the groups and widgets that make it up. Here is a simple, "hello world" dialog:

```
  <PropertyList>

   <name>hello</name>

   <width>150</width>
   <height>100</height>
   <modal>false</modal>
   <draggable>true</draggable>
   <resizable>true</resizable>

   <text>
    <x>10</x>
```

```
    <y>50</y>
    <label>Hello, world</label>
    <color>
     <red>1.0</red>
     <green>0.0</green>
     <blue>0.0</blue>
    </color>
   </text>

   <button>
    <x>40</x>
    <y>10</y>
    <legend>Close</legend>
    <binding>
     <command>dialog-close</command>
    </binding>
   </button>

  </PropertyList>
```

The dialog contains two sub-objects: a text field and a button. The button contains one binding, which closes the active dialog when the user clicks on the button.

Coordinates are pseudo-pixels. The screen is always assumed to be 1024x768, no matter what the actual resolution is. The origin is the bottom left corner of the screen (or parent dialog or group); x goes from left to right, and y goes from bottom to top.

All objects, including the top-level dialog, accept the following properties, though they will ignore any that are not relevant:

x - the X position of the bottom left corner of the object, in pseudo-pixels. The default is to center the dialog.

y - the Y position of the bottom left corner of the object, in pseudo-pixels. The default is to center the dialog.

width - the width of the object, in pseudo-pixels. The default is the width of the parent container.

```
height - the height of the object, in pseudo-pixels.  The default is
  the width of the parent container.

border - the border thickness, in pseudo-pixels.  The default is 2.

color - a subgroup to specify the dialogs color:
 red   - specify the red color component of the color scheme.
 green - specify the green color component of the color scheme.
 blue  - specify the blue color component of the color scheme.
 alpha - specify the alpha color component of the color scheme.

font - a subgroup to specify a specific font type
 name - the name of the font (excluding it's .txf extension)
 size - size of the font
 slant -  the slant of the font (in pseudo-pixels)

legend - the text legend to display in the object.

label - the text label to display near the object.

property - the name of the FlightGear property whose value will
  be displayed in the object (and possibly modified through it).

binding - a FlightGear command binding that will be fired when the
  user activates this object (more than one allowed).

keynum - the key code of a key that can be used to trigger the
  widget bindings via keyboard (e.g. <keynum>97</keynum> for
  the "a" key.

key - like "keynum", but takes a character ("a", "A", "Shift-a",
  "Shift-A", "Ctrl-a", "%", etc.), or symbolic key name ("Tab",
  "Return" = "Enter", "Esc" = "Escape", "Space", "&amp;" = "and",
  "&lt;", "&gt;", "F1" -- "F12", "Left", "Up", "Right", "Down",
  "PageUp", "PageDn", "Home", "End", "Insert"). Note that you
  can't use "<", ">", and "&" directly.

default - true if this is the default object for when the user
  presses the [RETURN] key.
```

```
 visible - if set to false, hides the whole widget that it is used
   in, along with its children. There's no empty space reserved
   for such widgets. The "visible" property can also be used to hide
   other XML groups from the layouter.

Objects may appear nested within the top-level dialog or a "group"
or a "frame" object.  Here are all the object types allowed, with their
special properties:


dialog
------

The top-level dialog box; the name does not actually appear in the
file, since the root element is named PropertyList.

  name - (REQUIRED) the unique name of the dialog for use with the
    "dialog-show" command.

  modal - true if the dialog is modal (it blocks the rest of the
    program), false otherwise.  The default is false.

  draggable - false if the dialog is not draggable. The default is true.

  resizable - false if the dialog is not resizable. The default is false.

  nasal - Nasal definition block
    open - Nasal script to be executed on dialog open
    close - Nasal script to be executed on dialog close

All Nasal code runs in a dialog namespace. Nasal bindings can
directly access variables and functions defined in an <open> block.
settimer() and setlistener() functions have to be removed manually
in the <close> block if they shouldn't remain active.


Example:

<PropertyList>
```

```
 <name>sample</name>
 <width>500</width>
 <height>210</height>
 <modal>false</modal>

 <text>
  ...
 </text>

 <button>
  ...
 </button>

</PropertyList>
```

group and frame

A group of subobjects. This object does not draw anything on the screen, but all of its children specify their coordinates relative to the group; using groups makes it easy to move parts of a dialog around.

A frame is a visual representation of a group and has a border and an adjustable background color.

Example:

```
  <group>
   <x>0</x>
   <y>50</y>

   <text>
    ...
   </text>

   <input>
    ...
```

```
   </input>

   <button>
    ...
   </button>

  </group>


input
-----

A simple editable text field.

Example:

  <input>
   <x>10</x>
   <y>60</y>
   <width>200</width>
   <height>25</height>
   <label>sea-level temperature (degC)</label>
   <property>/environment/temperature-sea-level-degc</property>
  </input>


text
----

A non-editable text label.

Example:

  <text>
   <x>10</x>
   <y>200</y>
   <label>Heading</label>
  </text>

  <text>
```

```
   <x>10</x>
   <y>200</y>
   <label>-9.9999</label> <!-- placeholder for width -->
   <format>%-0.4f m</format>
   <property>/foo/altitude</property>
  </text>


checkbox
--------

A checkbox, useful for linking to boolean properties.

Example:

  <checkbox>
   <x>150</x>
   <y>200</y>
   <width>12</width>
   <height>12</height>
   <property>/autopilot/locks/heading</property>
  </checkbox>



button
------

A push button, useful for firing command bindings.

  one-shot - true if the button should pop up again after it is
    pushed, false otherwise.  The default is true.

  <button>
   <x>0</x>
   <y>0</y>
   <legend>OK</legend>
   <binding>
    <command>dialog-apply</command>
   </binding>
```

```
   <binding>
    <command>dialog-close</command>
   </binding>
   <default>true</default>
  </button>
```

```
combo
-----

A pop-up list of selections.

  value - one of the selections available for the combo.  There may be
  any number of "value" fields.

Example:

  <combo>
   <x>10</x>
   <y>50</y>
   <width>200</width>
   <height>25</height>
   <property>/environment/clouds/layer[0]/type</property>
   <value>clear</value>
   <value>mostly-sunny</value>
   <value>mostly-cloudy</value>
   <value>overcast</value>
   <value>cirrus</value>
  </combo>
```

```
list
----

like "combo", but displays all values in a scrollable list box with
slider on the right side. Updates the <property> to the selected
entry. On <dialog-update> re-scans the <value> nodes and updates
the list.
```

```
airport-list
------------

like "list", but fills the list automatically with all airports known
to FlightGear. Calls bindings on airport selection and returns the
selected entry in <property> on dialog-apply. Interprets <property>
as search term on dialog-update.



property-list
-------------

like "list", but shows a list of properties from the global property
tree. The widget handles navigation in the property tree. It calls its
bindings on property selection and returns the path of the selected
property in <property> on dialog-apply. It's up to the caller to check
if the path belongs to a dir node or a value node. The widget shows
the contents of the dir property given in <property> on dialog-apply.
It does *not* handle setting of property values! Clicking on some
entries with the "control" or "shift" key pressed has a special meaning:

Ctrl +
  "."     ->  toggle verbose mode (shows flags, listeners, dir-values)
  ".."    ->  go to root node
  (bool)  ->  toggle bool value

Shift +
  "."     ->  dump contents of that tree level to the terminal

The flags printed after the node type have the following meaning:

  r       ->  read protected
  w       ->  write protected
  R       ->  trace read operations    (in the terminal window)
  W       ->  trace write operations
  A       ->  archive bit set
```

```
  U       ->  user archive bit set
  P       ->  preserved bit set (value is preserved on sim-reset)
  T       ->  property is "tied"

  Ln      ->  number of listeners attached to this node
```

```
select
------

A box with arrow buttons that cycle through a list of values.

Example:

  <select>
   <x>10</x>
   <y>50</y>
   <width>200</width>
   <height>25</height>
   <property>/sim/aircraft</property>
   <value>bo105</value>
   <value>ufo</value>
  </select>
```

```
slider
------

A horizontal or vertical slider for setting a value.

  vertical - true if the slider should be vertical, false if it should
    be horizontal.  The default is false.

  min - the minimum value for the slider.  The default is 0.0.

  max - the maximum value for the slider.  The default is 1.0.

  step - set to non-null if slider should move in steps.  The default is 0.0 (off).
```

```
  pagestep - set to non-null to enable page-stepping.  The default is 0.0 (off).

  fraction - size of the slider handle. Range: 0..1.  The default is 0.0 (minimum).

Example:

  <slider>
   <x>10</x>
   <y>50</y>
   <width>200</width>
   <property>/environment/visibility-m</property>
   <min>5</min>
   <max>50000</max>
  </slider>


dial
----

A circular dial for choosing a direction.

  wrap - true if the dial should wrap around, false otherwise.  The
    default is true.

  min - the minimum value for the dial.  The default is 0.0.

  max - the maximum value for the dial.  The default is 1.0.

Example:

  <dial>
   <x>10</x>
   <y>50</y>
   <width>20</width>
   <property>/environment/wind-from-direction-deg</property>
   <min>0</min>
   <max>360</max>
  </dial>
```

```
textbox
-------

The text will be retrieved/buffered from/within a specified
property tree, like:

<textbox>
    <!-- position -->
    <x>100</x>
    <y>100</y>

    <!-- dimensions -->
    <width>200</width>
    <height>400</height>

    <property>/gui/path-to-text-node/contents</property>

    <slider>15</slider> <!--width for slider -->
    <wrap>false</wrap> <!-- don't wrap text; default: true -->
    <top-line>0</top-line <!-- line to show at top, -ve numbers: show last line -->

    <editable>true</editable> <!-- if the puLargeInput is supposed to be editable -->
</textbox>


hrule/vrule
-----------

Draws a horizontal/vertical line that, by default, expands to full width/height.
Its thickness can be set with <pref-height>/<pref-width>.

  <hrule>
    <color>
      <red>1.0</red>
      <green>0.0</green>
      <blue>0.0</blue>
    </color>
    <pref-height>2</pref-height>
  </hrule>
```

GLOBAL SETTINGS ("THEMES")

FlightGear reads GUI style information from /sim/gui/, which is by default loaded from file $FG_ROOT/gui/style.xml. This file contains one <font> and one <colors> group:

global font settings

```
  <sim>
    <gui>
      <font>
        <name type="string">Helvetica.txf</name>
        <size type="float">15</size>
        <slant type="float">0</slant>
      </font>
    </gui>
  <sim>
```

<name> can either be the name of a built-in bitmap font (one of: "FIXED_8x13", "FIXED_9x15", "TIMES_10", "TIMES_24", "HELVETICA_10", "HELVETICA_12", "HELVETICA_14", "HELVETICA_18", "SANS_12B"), or the name of a texture font in the $FG_FONT directory. $FG_FONT is by default set to $FG_ROOT/Fonts/. Properties <size> and <slant> are only applied to texture fonts, and otherwise ignored.

global color settings

These define the color of the splash screen font, and the color of the GUI elements. All colors are in /sim/gui/colors/ and follow the same pattern:

```
<sim>
  <gui>
    <colors>
      <!-- splash screen font color; ignores <alpha> value -->
      <splash>
        <red type="float">1.0</red>
        <green type="float">0.9</green>
        <blue type="float">0.0</blue>
      </splash>
    </colors>
  </gui>
</sim>
```

As listed above, FlightGear implements several GUI elements:

```
(1)    "dialog"      "group"         "frame"       "hrule"      "vrule"
       "list"        "airport-list"  "input"       "text"       "checkbox"
       "radio"       "button"        "combo"       "slider"     "dial"
       "textbox"     "select"
```

The underlying plib library uses six colors for each GUI element.
These are:

```
(2)    "background"  "foreground"    "highlight"
       "label"       "legend"        "misc"
```

"button", for example, uses the first four colors from (2), while it ignores "legend" and "misc" color. "text" only uses "label", and ignores the rest. In some cases the use of colors isn't obvious and you have to try or look up the plib sources to be sure. GUI colors can be defined for each of the categories from (1) and (2), and for combinations of them:

```
(3)    "button-legend"   "input-misc"    etc.
```

FlightGear has default colors for (2) built-in. Let's call them (0).
And this is how colors for individual GUI elements are determined,
if, for example, a button is to be drawn:

  For the button's background:
  a. read the hard-coded default "background" color from (0) as base
  b. merge the global "background" color from (2) in (if defined)
  c. merge a global color "button-background" from (3) in (if defined)
  d. merge a specific <color> from the dialog's XML file in (if defined)

  Repeat the four steps for the button's "foreground", "highlight",
  etc. color.

If you write a style file, you'll most likely start with the colors
from (2):

```
 <sim>
   <gui>
     <colors>
       <background>
         <red type="float">0.6</red>
         <green type="float">0.0</green>
         <blue type="float">0.0</blue>
         <alpha type="float">1.0</alpha>
       </background>

       <foreground>
       ...
```

This makes all dialogs dark red. But you don't, for example, want buttons
to be red, but yellow. So you define another color for buttons:

```
       <button>
         <red type="float">1.0</red>
         <green type="float">0.9</green>
         <blue type="float">0.0</blue>
         <alpha type="float">1.0</alpha>
```

```
      </button>
      ...
```

This sets all of a button's six colors (2) to some shades of red. plib does this automatically. The lower and right border ("foreground") will be darker, the upper and left border will be lighter ("highlight"). If you aren't happy with plib's choice, you can set each of the colors explicitly. Let's say, we want the text on the button blue (3):

```
      <button-legend>
        <red type="float">0.3</red>
        <green type="float">0.3</green>
        <blue type="float">1.0</blue>
        <alpha type="float">1.0</alpha>
      </button-legend>
      ...
```

To set the cursor color from input fields, you'd define "input-misc", etc.

You can change colors and font at runtime. Just open the property browser, go to /sim/gui/colors and change whatever you like. The new color will only take effect, though, if you re-init the GUI. There's a menu entry for that, and you can define a key binding for it:

```
  <key n="99">
    <name>c</name>
    <desc>Re-init GUI</desc>
    <binding>
      <command>reinit</command>
      <subsystem>gui</subsystem>
    </binding>
  </key>
```

Note that this will currently close all open dialogs!

__end__

13 Hud

```
This document describes the *new* HUD system that will be first released
with fgfs >0.9.10. For the old system see $FG_ROOT/Docs/README.xmlhud.
Note that the old system is scheduled for removal, and that the new system
is work in progress. So it's up to you to choose the lower risk.  :-)

################################################################################

A HUD configuration file may contain 3 types of information:

  (1) global settings
  (2) HUD instrument definitions
  (3) imports of further HUD config files

(1) global settings ============================================================

These can be used to override settings in the global property tree. Currently
only bool <enbale-3d> is supported. It allows a HUD to define itself if it is
a 2D HUD (false) or a 3D HUD (true). 2D HUDs always remain in the screen plane,
while 3D HUDs always remain in a position relative to the aircraft.

Example:

    <enable-3d>true</enable-3d>
```

(2) HUD instrument definitions ==

These define one single HUD "item" (instrument or label), and consist of several
properties. Some of those are standardized property groups that can be used
in many places. These shall be explained first.

(2.1) standardized property groups --

1. <condition> group
2. input channel group
3. <option>s

(2.1.1) <condition> ....

These define conditions that are either "true" or "false". They are used to
hide/unhide whole items, or to set other item states (blinking on/off) etc.
You find detailed documentation about them in $FG_ROOT/Docs/README.conditions.

(2.1.2) input channel groups ....

These define an input channel to the HUD instrument and serve as interface
between property system and the instrument. A complete channel definition
looks like this (defaults in comments):

```
  <input>
      <property>/position/altitude-agl-ft</property>  <!-- no default -->
      <factor>0.3048</factor>                         <!-- 1.0 -->
      <offset>2.0</offset>                            <!-- 0.0 -->
      <damp>1.5</damp>                                <!-- 0.0 (no damping) -->
      <min>0.0</min>                                  <!-- -infinity -->
      <max>10000</max>                                <!-- +infinity -->
  </input>
```

Input channels are only called <input> for instruments that only have one

channel. Other instruments may have two or more channels, called <bank-input>, <pitch-input> etc. All of them will have the same member properties and behave the same.

An input channel will preprocess the raw property value for the HUD instrument. The property may be of any type (bool, int, long, float, double, string), but not all types will make sense in every situation. The HUD instrument will only see the final value, which is calculated as:

```
v = <property> * <factor> + <offset>
if (<damp>)     v = EWMA_lowpass(v, <damp>)
if (v < <min>)  v = <min>
if (v > <max>)  v = <max>
```

The EWMA_lowpass filter (Exponentially Weighted Moving Average) is calculated like so:

```
coeff = 1.0 - 1.0 / 10^<damp>
v = average = (average * coeff) + (v * (1.0 - coeff))
```

That is, a <damp> value of 0 will cause no damping. A damping value of 1 will make a coefficient of 0.9, which means that the resulting value will be 9/10 of the average plus 1/10 of the new value. A damping value of 2 will make a coefficient of 0.99 and hence result in a value of 99/100 the average plus 1/100 the new value etc. The higher the <damp> value, the more damped will the output value be.

2.1.3 <option> .....

Most HUD instruments accept one or more options from a common set. It will be explaind in the respective intrument descriptions which options are actually used by that instrument. Possible values are:

```
  <option> autoticks </option>
  <option> vertical </option>   \___orientation of <tape>
  <option> horizontal </option> /
  <option> top </option>          \
  <option> left </option>         |___place of numbers in <tape>, <gauge>
  <option> bottom </option>       |   top/bottom for turn-bank-indicator, etc.
  <option> right </option>        /
  <option> both </option>           _left/right for vert. and top/bottom for hor.
  <option> noticks </option>
  <option> arithtic </option>
  <option> decitics </option>
  <option> notext </option>       ___no numbers on <tape>
```

Example:

```
  <tape>
      <option>left</option>
      <option>vertical</option>
      ...
  </tape>
```

(2.1) properties common to all instruments ----------

All HUD instruments will accept the following common properties (shown on a <tape> instrument):

```
  <tape>
      <name>foo tape</name>
      <x>-100</x>                       <!-- 0 == center -->
      <y>-60</y>                        <!-- 0 == center -->
      <width>20</width>                 <!-- 0 -->
      <height>120</height>              <!-- 0 -->
      <condition>...</condition>        <!-- see section 2.1.1; default: true -->
```

```
    ...
  </tape>

The <name> is only a description for the instrument to make reading the config
easier. It's output in --log-level=info, but not otherwise used. The coordinates
define the place and size of the instrument. They are relative to the origin of
their parent, which is the middle of the HUD/screen by default. Positive <x> are
on the right, positive <y> in the upper half. The <condition> hides/reveals the
whole instrument.
```

(2.2) HUD instruments

(2.2.1) <label>

```
Draws a formatted string or number.

Text:
  <format>   ... printf-style format with only one % item.  Example:  "%2.3lf ft"
  <prefix>   ... prefix text  \___ in addition to the <format>
  <postfix>  ... postfix text /
  <halign>   ... one of "left", "center" (default), "right".

Box:
  <box>      ... draw box around label (default: false)
  <option>   ... one of (left|right|top|bottom)  ... draw arrow on this side
  <pointer-width>  ... size of pointer base
  <pointer-lenfth> ... distance of base--peak

  <blinking>
      <interval>                  ... on/off-time in seconds (default: -1 == off)
      <condition>...</condition>  ... see secion 2.1.1       (default: true)
  </blinking>
```

```
TODO:
  <digit>    ... number of insignificant digits (those will be printed smaller)


Example:

  <label>
      <name>G Load</name>
      <x>-40</x>
      <y>25.5</y>
      <width>1</width>
      <height>1</height>

      <input>
          <property>/accelerations/pilot/z-accel-fps_sec</property>
          <factor>-0.03108095</factor>
          <damp>1.3</damp>
      </input>

      <format>%2.1f</format>
      <halign>right</halign>
      <box>true</box>
      <option>bottom</option>    <!-- pointer on the lower edge -->

      <blinking>
          <interval>0.25</interval>
          <condition>
              <or>
                  <less-than>      <!-- G load > 2.0 -->
                      <property>/accelerations/pilot/z-accel-fps_sec</property>
                      <value>-64.3481</value>
                  </less-than>

                  <greater-than>   <!-- G load < -1.0 -->
                      <property>/accelerations/pilot/z-accel-fps_sec</property>
                      <value>31.17405</value>
                  </greater-than>
              </or>
```

```
          </condition>
      </blinking>
  </label>
```

```
(2.2.2) <tape> ..........................................................
SCALE:
    input
    major-divisions
    minor-divisions
    modulo
    display-span

TAPE:
    tick-bottom
    tick-top
    tick-right
    tick-left
    cap-bottom
    cap-top
    cap-right
    cap-left
    marker-offset
    enable-pointer
    zoom

    pointer-type   (moving|fixed)
    tick-type      (circle|line)
    tick-length    (constant|variable)
```

(2.2.3) <dial> .....
SCALE:
    input
    major-divisions
    minor-divisions
    modulo
    display-span

TAPE:
    radius
    divisions

(2.2.4) <gauge> .....
SCALE:
    input
    major-divisions
    minor-divisions
    modulo
    display-span

(2.2.5) <turn-bank-indicator> .....
    bank-input
    sideslip-input

```
    gap-width
    bank-scale
```

```
(2.2.6) <ladder> ..........................................................
    pitch-input
    roll-input
    display-span
    divisions
    screen-hole
    compression-factor
    enable-fuselage-ref-line
    enable-target-spot
    enable-velocity-vector
    enable-drift-marker
    enable-alpha-bracket
    enable-energy-marker
    enable-climb-dive-marker
    enable-glide-slope-marker
    glide-slope
    enable-energy-marker
    enable-waypoint-marker
    enable-zenith
    enable-nadir
    enable-hat
    type       (pitch|climb-dive)
```

```
(2.2.7) <runway> ..........................................................
    arrow-scale
    arrow-radius
    line-scale
    scale-dist-nm
    outer_stipple
    center-stipple
    arrow-always

reads directly:
    /position/altitude-agl-ft,
    /sim/view[0]/config/pitch-pitch-deg
    /sim/view[0]/config/pitch-heading-deg




(2.2.8) <aiming-reticle> ..................................................

Draws MIL-STD-1787B aiming reticle. Size of bullet and inner circle are
determined from <width>. The outer circle radius is changeable at runtime.

  <active-condition> ... true:  stadiametric (4.2.4.4)  (default)
                         false: standby (4.2.4.5)
  <diameter-input>   ... input channel: diameter of outer circle relative to
                         inner circle; default: 2.0 (= twice as big)




(3) <import> ==============================================================

Imports another HUD config into the current one. This can be a file defining
a single instrument ($FG_ROOT/Huds/Instruments/*.xml), a set of instruments
($FG_ROOT/Huds/Sets/*.xml) or a mixture of both (for example a complete HUD
```

on its own). The x/y offets moves the reference point for the included items relative to the current reference point.

```
    <import>
        <path>Huds/Sets/controls.xml</path>
        <x-offset>-100</x-offset>
        <y-offset>70</y-offset>
    </import>
```

Imported files can import further files. This is allowed for up to 10 levels. This is an arbitrary number and can easily be changed in the code if necessary.

When fgfs is called with --log-level=info, then it outputs a graphical trees of all loaded/imported files, with the instruments shown as leafs.

14 Introduction

Internals

The core of FlightGear is the property system. This is a tree like internal representation of global variables. The property system is explained more in detail later on.

FlightGear' way of doing things is breaking it up into small pieces. There is (for example) animation code that reacts on property changes. There is also a Flight Dynamics model (FDM) that (amongst other things) updates properties. There is a menu system that can display and alter properties. Then we have sound code that plays sound based on ... properties.

Maybe you see a pattern evolve by now.

All subsystems are almost self containing. Most of the time they only read the values of some properties, and sometimes they alter other properties. This is the basic way of communicating between subsystems.

Property System

The property system is best described as an in-memory LDAP database which holds the state of global variables. The system has a tree like hierarchy (like a file system) and has a root node, sub nodes (like subdirectories) and end-nodes (variables).

All variables are kept internally as raw values and can be converted to any other supported type (boolean, int, float double and string).

Like a file system, every node can be accessed relative to the current node, or absolute to the root node.

The property system also allows aliasing nodes to other nodes (like symbolic linking files or directories to other files or directories) and may be assigned read-only or read-write.

If necessary it would be possible for parts of the program to hold it's own property tree, which is inaccessible from the global property tree, by keeping track of it's own root-node.

Property I/O code allows one to easily read the tree from, or write the tree to an XML file.

Subsystems

To add a new subsystem you would have to create a derived class from SGSubsystem and define at least a small set of functions:

```
class FGFX : public SGSubsystem
{
public:

  FGFX ();
  virtual ~FGFX ();

  virtual void init ();
```

```
  virtual void reinit ();
  virtual void bind ();
  virtual void unbind ();
  virtual void update (double dt);
}
```

The init() functions should make sure everything is set and ready so the update() function can be run by the main loop. The reinit() function handles everything in case of a reset by the user.

The bind() and unbind() functions can be used to tie and untie properties.

After that you can register this class at the subsystem manager:

```
globals->add_subsystem("fx", new FGFX);
```

Now the subsystem manager calls the update() function of this class every frame. dt is the time (in seconds) elapsed since the last call.

Scripting

The scripting langage Nasal can also read and modify properties but it can also be incorporated into the menu system. The documentation for Nasal can be found here: http://www.plausible.org/nasal/flightgear.html

15 IO

This document describes how to invoke FlightGear's generic IO subsystem.

FlightGear has a fairly flexible generic IO subsystem that allows you to "speak" any supported protocol over any supported medium. The IO options are configured at runtime via command line options. You can specify multiple entries if you like, one per command line option.

The general form of the command line option is as follows:

```
    --protocol=medium,direction,hz,medium_options,...

    protocol = { native, nmea, garmin, fgfs, rul, pve, ray, etc. }
    medium = { serial, socket, file, etc. }
    direction = { in, out, bi }
    hz = number of times to process channel per second (floating
         point values are ok.


Generic Communication:

    --generic=params

    With this option it is possible to output a pre-configured
    ASCII string or binary sequence  using a predefined separator.
    The configuration is defined in an XML file located in the
    Protocol directory of the base package.

    params can be:
    serial port communication:    serial,dir,hz,device,baud,protocol
    socket communication:         socket,dir,hz,machine,port,style,protocol
    i/o to a file:                file,dir,hz,filename,protocol

    See README.protocol for how to define a generic protocol.


Serial Port Communication:

    --nmea=serial,dir,hz,device,baud

    device = OS device name of serial line to be open()'ed
    baud = {300, 1200, 2400, ..., 230400}

    example to pretend we are a real gps and output to a moving map application:

    --nmea=serial,out,0.5,COM1,4800

    Note that for unix variants you might use a device name like "/dev/ttyS0"
```

```
Socket Communication:

    --native=socket,dir,hz,machine,port,style

    machine = machine name or ip address if client (leave empty if server)
    port = port, leave empty to let system choose
    style = tcp or udp

    example to slave one copy of fgfs to another

    fgfs1:  --native=socket,out,30,fgfs2,5500,udp
    fgfs2:  --native=socket,in,30,,5500,udp --fdm=external

    This instructs the first copy of fgfs to send UDP packets in the
    native format to a machine called fgfs2 on port 5500.

    The second copy of fgfs will accept UDP packets (from anywhere) on
    port 5500.  Note the additional --fdm=external option.  This tells
    the second copy of fgfs to not run the normal flight model, but
    instead set the FDM values based on an external source (the
    network in this case.)


File I/O:

    --garmin=file,dir,hz,filename

    filename = file system file name

    example to record a flight path at 10 hz:

    --native=file,out,10,flight1.fgfs

    example to replay your flight

    --native=file,in,10,flight1.fgfs --fdm=external

    You can make the replay from a file loop back to the beginning
    when it reaches the end of the file with the "repeat" flag:
```

```
    --generic=file,in,20,flight.out,playback,repeat

    With a numeric argument, FlightGear will exit after that number of repeats.
    --generic=file,in,20,flight.out,playback,repeat,5
```

Moving Map Example:

Per Liedman has developed a moving map program called Atlas (atlas.sourceforge.net) The initial inspiration and much code came from Alexei Novikov.

The moving map supports NMEA format input either via network or via serial port. Either way will work, but this example demonstrates the use of a socket connection.

Start up fgfs with:

```
    fgfs --nmea=socket,out,0.5,atas-host-name,5500,udp
```

Start up the Atlas program with:

```
    Atlas --udp=5500 --fgroot=path-to-fg-root --glutfonts
```

Once both programs are running, the Atlas program should display your current location. Atlas is a really nifty program with many neat options such as the ability to generate and use background bitmaps that show the terrain, cities, lakes, oceans, rivers, etc.

HTTP Server Example

You can now interact with a running copy of FlightGear using your web browser. You can view all the key internal variables and even change the ones that are writable. If you have support in your favorite [scripting] language for interacting with an http server, you should be able to use this as a mechanism to interface your script with FlightGear.

Start up fgfs with the --httpd=<port#> option:

For example:

fgfs --httpd=5500

Now point your web browser to:

http://host.domain.name:5500/

When a value is displayed, you can click on it to bring up a form to assign it a new value.

ACMS flight data recorder playback

fgfs --fdm=acms --generic=file,in,1,<path_to_replay_file>,acms

16 Joystick

Replaced by Docs/README.Joystick.html in the base package.

17 JSBsim

JSBSim

JSBSim is an ongoing attempt at producing an OO Flight Dynamics Model (FDM) to replace LaRCsim as the default FDM for FlightGear. It can also be used standalone.

JSBSim uses config files to represent aircraft, engines, propellers, etc. Also, the flight control system is described in the config file. Normally, for use with FlightGear, the config files are named this way [case is significant]:

<FG_ROOT>/Aircraft/<aircraft name>/<aircraft name>.xml

Engines are named like this:

<FG_ROOT>/Engines/<engine name>.xml

Aircraft and engine config files are present in the FGFS Base package which must be downloaded. See the FlightGear web site for more information.

How to run FGFS using JSBSim

All the various FDMs are currently compiled into FGFS. You can specify which FDM you want at run time. You can also specify which aircraft you want. Currently, for JSBSim only the X-15 and C-172 aircraft are available. Here is an example command line used to start up FlightGear using JSBSim as the FDM:

```
fgfs --fdm=jsb --aircraft=X15 --units-feet --altitude=60000 --uBody=2000 --wBody=120
```

or,

```
fgfs --fdm=jsb --aircraft=c172
```

[Note: uBody is the forward velocity of the aircraft, wBody is the downward velocity - from the aircraft point of view. This essentially means that the aircraft is going forward fast and has an angle of attack of about 4 degrees or so]

The first command line sets up the initial velocity and altitude to allow the X15 to glide down. Note that if you fire up the engine, it will burn for only about two minutes and then run out of fuel - but you will go very, very fast! The second command line example will start up the C172 on the end of the runway.

Check out the JSBSim home page at http://jsbsim.sf.net. Please report any bugs to jsb@hal-pc.org, or apeden@earthlink.net, or post on the jsbsim web site using the SourceForge bug tracking system for the project.

JSBSim is written by Jon S. Berndt and Tony Peden with contributions by other FlightGear programmers, as well.

18 Jsclient

```
Start flightgear with
fgfs --jsclient=socket,in,<hz>,,<port>,udp \
     --prop:/jsclient/axis[i]="/property/you/want/to/control" \
     --prop:/jsclient/axis[i+1]="/another/property/you/want/to/control" ...
eg:
# fgfs --aircraft=yf23-yasim --airport=KEMT --jsclient=socket,in,5,,16759,udp \
  --prop:/jsclient/axis[0]="/controls/flight/spoilers" \
  --prop:/jsclient/axis[1]="/radios/comm/volume"

Start the server on the machine with the remote gameport:
JsServer <host> <port>
eg:
# JsServer 192.168.1.1 16759

(JsServer can be started before or after fgfs)
```

19 Layout

```
I just commited an implementation of GUI layout management, ported
over from my game project last year*.  What this means is that you no
longer need to position your widgets manually in dialogs, and can
instead lay them out in tables and boxes like the pros do. :) I've
redone a few of the dialogs using the new scheme (I'm especially proud
of the autopilot dialog: http://plausible.org/andy/autopilot-new.png),
so you can see what the possibilities look like.

* FWIW, this is almost the last of my useful code from last spring.
  Nasal and the Plib vertex splitting code are two other bits that
  were useful in isolation.  I also had a terrain engine and stencil
  shadow implementation, but those weren't really production quality.

Basically, the implementation is a preprocessor on top of the existing
dialog properties, which sets x/y/width/height values based on
constraints.  The <group> objects, including the top-level one which
represents the whole dialog, can now have a <layout> property, which
can be "hbox", "vbox", or "table".
```

The boxes simply lay out their children in order, either top-to-bottom or left-to-right. The box name comes from Qt and Gtk, but this is also the same thing that Java calls a "flow layout", or what the Tk "packer" does. You can set "constraint" properties on the children, to give the layout manager hints as to how to place the children. For the boxes, these are:

- equal: The box manager makes sure that all the widgets with this constraint set to true get equal sizes big enough to fit the largest one. This is very useful for button boxes to make the "OK" and "Cancel" buttons match, for example.
- stretch: Cells with "stretch" set to true get all the extra space, if any, the box has to allocate. These are useful for alignment purposes, especially when combined with <empty> "widgets" (which are ignored by the dialog creation code, but honored by the layout engine).

The table layout will be a little more familiar to anyone with HTML experience. Children of tables get the following constraints:

- row: The row number containing the upper left corner of the widget. Table rows are zero-indexed.
- col: The column number containing the upper left corner of the widget. Table columns are zero-indexed.
- rowspan: The number of rows spanned by the widget. Defaults to one.
- colspan: The number of columns spanned by the widget. Defaults to one.

Inside of each "cell", regardless of parent layout, there are some constraints that are used to position the widget within the space available:

- halign: The horizontal alignment. Can be "left", "right", "center", or "fill" (i.e. stretch to available space).
- valign: The vertical alignment. Can be "top", "bottom", "center", or "fill".
- padding: The number of pixels to leave between the edge of the cell and the widget.
- pref-height:
- pref-width: Overrides the default preferred size of the widget.

Note that this is the size of the widget only, not the
cell (which includes padding).

Also, the padding values for cells in a group can be set to a default value with a <default-padding> property on the group widget.

Some will ask why didn't I implement this as part of Pui. The problem is the pui just isn't set up for it. Not only is there no notion of "preferred" size for a widget, there isn't anything remote like a "constraint" system for attaching arbitrary values to widgets. With the property system, I have that for free (the original code was written to work with Nasal objects, btw). I can do the layout with the properties and on the properties, and our existing dialog code hardly needs to change at all.

Anyway, give it a try and see if I've broken anything. Also, note that some of these changes *do* modify the visual appearance of the GUI. I think it looks better, but opinions will no doubt vary. Shout if you hate it.

And finally, the text alignment doesn't quite look right with current plib due to some minor rendering bugs. Bug Steve to apply the patch I submitted a week or so ago. :)

Andy

20 Logging

Logging in FlightGear

[Note: JSBSim also has its own independent logging facilities, which are not discussed here.]

FlightGear can log any property values at any interval to one or more CSV files (which can be read and graphed using spreadsheets like Gnumeric or Excel). Logging is defined in the '/logging' subbranch of the main property tree; under '/logging', each '/log' subbranch

defines a separate log with its own output file and interval. Here is a simple example that logs the rudder and aileron settings every second (1000ms) to the file steering.csv, using a comma (the default, anyway) as the field delimiter:

```
<PropertyList>
 <logging>
  <log>
   <enabled>true</enabled>
   <filename>steering.csv</filename>
   <interval-ms>1000</interval-ms>
   <delimiter>,</delimiter>
   <entry>
    <enabled>true</enabled>
    <title>Rudder</title>
    <property>/controls/flight/rudder</property>
   </entry>
   <entry>
    <enabled>true</enabled>
    <title>Ailerons</title>
    <property>/controls/flight/aileron</property>
   </entry>
  </log>
 </logging>
</PropertyList>
```

Each 'log' subbranch contains a required 'enabled' property, an optional 'filename' property (defaults to "fg_log.csv"), an optional 'delimiter' property (defaults to a comma), an optional 'interval-ms' property (defaults to 0, which logs every frame), and a series of 'entry' subbranches. The 'delimiter' property uses only the first character of the property value as the delimiter. Note that the logger does no escaping, so you must choose a delimiter that will not appear in the property values (that's not hard, since most of the values are numeric, but watch for commas in the titles).

Each 'entry' subbranch contains a required 'enabled' property, a 'property' property specifying the name of the property to be logged, and an optional 'title' property specifying the title to use in the CSV file (defaults to the full path of the property). The elapsed

time in milliseconds since the start of the simulation is always included as the first entry with the title "Time", so there is no need to include it explicitly.

Here's a sample of the logging output for the above log:

```
Time,Rudder,Ailerons
6522,0.000000,0.000000
7668,-0.000000,0.000000
8702,-0.000000,0.000000
9705,-0.000000,0.000000
10784,-0.000000,0.000000
11792,-0.000000,0.000000
12808,-0.000000,-0.210000
13826,-0.000000,-0.344000
14881,-0.000000,-0.066000
15901,-0.000000,-0.806000
16943,-0.000000,-0.936000
17965,-0.000000,-0.534000
19013,-0.000000,-0.294000
20044,-0.000000,0.270000
21090,-0.000000,-1.000000
22097,-0.000000,-0.168000
```

Note that the requested interval is only a minimum; most of the time, the actual interval is slightly longer than the requested one.

The easiest way for an end-user to define logs is to put the log in a separate XML file (usually under the user's home directory), then refer to it using the --config option, like this:

```
fgfs --config=log-config.xml
```

The output log files are always relative to the current directory.

--

David Megginson, last updated 2002-02-01

21 Materials

README.materials

This README describes the materials.xml file format. It is targeted at those wanting to change the appearance of the scenery in FlightGear.

As is the norm in FG, the materials.xml file is a properties file. However, it is only read on startup, is not part of the main property tree and cannot be changed at runtime.

The properties file consists of a number of <material> entries, each of which describes a single visually distinct terrain material in the FG world.

The rest of this document describes the children tags of the <material> entry.

name : Scenery type names that map to this material. These are typically taken from landclass definitions created by TerraGear. Multiple scenery types may map to a single material. This is recommended to minimize texture memory usage.

condition : A condition statement used to activate the material. Note that this if evaluated once at start-up.

texture : A relative path to an SGI RGB, PNG or DDS file containing a texture for the material. RGB and PNG are recommended for platform compatibility. You may define more than one <texture> element, in which case the scenery loader will choose one texture for each contiguous set of scenery triangles.

texture-set : If using an effect (see below), it may be necessary to define more than one texture. The texture-set element has multiple <texture> element children which may then be referenced by the effect. You may define more than one <texture-set> element, in which case the scenery loader will choose one texture for each contiguous set of scenery triangles.

object-mask : An optional bitmap file used to control random placement of lights, buildings and vegetation on the terrain. The green channel mask is used for random vegetation placement, the blue channel for buildings and lights. and the red channel controls the rotation of buildings (0.0 is North, 0.5

```
       is South). Fractional colour values can be used to give a probability of
       placement. Multiple object-masks may be defined to match up with <texture>
       or <texture-set> elements.

effect : The effect to be used for this material. (default:
       Effects/terrain-default)

       ambient, diffuse, specular, emissive, and shininess are copied into the
       parameter section of the effect created for this material.

parameters : Additional parameters to be used in the effect. See README.effects
            for format information.

wrapu : True if the texture should repeat horizontally over a surface, false if
       it should not repeat (default: true).

wrapv : True if the texture should repeat vertically over a surface, false if
       it should not repeat (default: true).

mipmap : True if the texture should be mipmapped, false otherwise. (default: true).

xsize : The horizontal size of a single texture repetition, in meters.

ysize : the vertical size of a single texture repetition, in meters

light-coverage : The coverage of a single point of light in m^2. 0 indicates no
        lights at all. Minimum value is 1000m^2. May be masked by the blue channel
        of an object-mask. Lights are all generated 3m above the surface, and
        have random colour (50% yellow, 35% white, 10% orange, 5% red)

ambient : The ambient light colour for the material, specified as separate
        r, g, b, a components (default: all color components 0.2, alpha 1.0).

diffuse : The diffuse light colour for the material, specified as separate
        r, g, b, a components (default: all color components 0.8, alpha 1.0).

specular : The specular light colour for the material, specified as separate
        r, g, b, a components (default: all color components 0.0, alpha 1.0).

emissive : The emissive light colour for the material, specified as separate
```

```
        r, g, b, a components (default: all color components 0.0, alpha 1.0).

solid : Whether the surface is solid from an FDM perspective. If it is not
        solid, it is assumed that the material models a fluid (water) surface.
        (default: true).

friction-factor : The friction factor for that material. The normalized
        factor can be used by a FDM to post-multiply all contact friction forces
        with that factor. That is the more slippery a material is the smaller
        this value should be. (default: 1.0 for Dry concrete/Asphalt).

rolling-friction : the gear rolling rolling-friction coefficient for this
        particular material. (default: 0.02 for Dry concrete/Asphalt).

bumpiness : normalized bumpiness factor for this particular terrain.
        (default: 0.0 for a smooth surface).

load-resistance : a pressure value how much force per surface area this
        surface can carry without deformation. The value should be in N/m^2
        (default: 1e30).

glyph : group that defines one letter/digit/symbol in a font texture
        sub-entries: name, left (default: 0.0), right (default: 1.0)
        (left and right describe the horizontal position in the texture.)

wood-coverage : The coverage of trees in areas marked as woodland in
         m^2. A lower number means a higher density of trees. A value of
         0 indicates no woods. May be masked by the green channel of an
         object-mask. (default: 0)

tree-range-m : The range at which trees become visible. Note that this
         is not absolute, as trees are loaded in blocks. A lower number means
         trees will not become visible until you are closer.

tree-texture : A texture to use for the trees. Typically this will contain around
         8 different trees in a row, duplicate 4 times. From bottom to top, the
         rows contain
         * summer textures
         * summer snow texture
         * winter texture
```

```
        * winter snow texture

        Each tree must have space at the top. For a 512x512 texture sheet, this
        should be 8 pixels.  Otherwise subsequent rendering results in "top hats"
        above trees in the distance where the trunk of the tree above in the
        textures sheet bleeds downwards when the mipmaps are generated.

tree-varieties : The number of different trees defined in the tree-texture
        horizontally. (default: 1)

tree-height-m : The average height of the trees. Actual tree height will
        vary by +/- 50%. (default: 0)

tree-width-m : The average width of the tree cover. Actual tree width will
        vary by +/- 50%. (default 0)

tree-max-density-angle-deg : The slope angle at which trees begin to thin out
        as the slope is too steep to support the full coverage. Shallower
        slopes have maximum wood-coverage.  Steeper slopes have fewer trees.
        (default : 45)

tree-zero-density-angle-deg : The angle at which the slope is too steep to
        support significant vegetation.  Steeper slopes have no trees.
        (default : 60)

object-max-density-angle-deg : The angle at which objects and buildings become
        less dense due to a steep slope. (default : 20)

object-zero-density-angle-deg : The angle at which the slope is too steep to build
        on.  No object/buildings will be placed on slopes steeper than this.
        (default : 30)

object-group : A group of random objects to be placed on the surface. Contains
        <range-m> and one or more <object> children.

range-m : The distance at which objects within this object-group become
        visible. Note that for realism, 60% of the objects will become visible
        at <range-m>, 30% at 1.5*<range-m>, and 10% at 2*<range-m>.
        (default: 2000)
```

object : A set of random objects to be placed. Contains <coverage-m2>, <path>
and <heading> children.

coverage-m2 : The coverage of a single object in m2. Lower values mean a higher
density. Minimum value is 1000.

spacing-m : The minimum space between this object and any other on the surface in
meters. This helps to avoid objects being placed ontop of each other.
(default 20)

path : Path relative to FG_ROOT to a model definition, usually .ac or .xml file.
More than one <path> may be included within the <object> tag, in which
case a single <path> is chosen at random for each individual object
placement.

heading-type : Indicator of how the heading of the random objects should be
determined. Valid values are:
fixed - Objects all point North. Default.
random - Objects are assigned an individual random heading
mask - Rotation is taken from the red channel of the object-mask
billboard - Object is always rotated to face camera - expensive

Random Buildings
================

Random Buildings come in three sizes, with individual constraints.

Small buildings. These have different textures on the sides compared to the front
and back. Small buildings are never deeper than they are wide.

Medium buildings, which are never taller than they are wide.

Large buildings. There are no constraints on their width, depth or height.

building-coverage : The coverage of random buildings in areas marked for random
objects in m^2. A lower number means a higher density of buildings. A
value of 0 indicates no buildings. May be masked by the blue channel of an
object-mask. (default: 0)

```
building-spacing-m : The minimum spacing between random buildings and other buildings
         or random objects. This helps avoid objects being placed on top of each
         other. (default: 5)

building-small-ratio: Ratio of small buildings. These buildings are 1-3 stories
         in height, and may have a pitched roof. Fraction of small buildings is
         (<building-ratio-small> / (<building-ratio-small> + <building-ratio-medium>
         + <building-ratio-large>). (default: 0.8)

building-medium-ratio : Ratio of medium buildings. These buildings are 3-6 stories
         in height, and have a flat roof. (default: 0.15)

building-large-ratio : Ratio of large buildings. These buildings are 5-10 stories in
         height, and have a flat roof. (default 0.05)

building-small-pitch : Fraction of small buildings with pitched roofs. (default 0.8)
building-medium-pitch : Fraction of small buildings with pitched roofs. (default 0.2)
building-large-pitch : Fraction of small buildings with pitched roofs. (default 0.1)

building-small-min-floors : Min. number of floors for a small building. (default 1)
building-small-max-floors : Max. number of floors for a small building. (default 3)

building-medium-min-floors  : Min. number of floors for a medium building. (default 3
building-medium-max-floors  : Max. number of floors for a medium building. (default 8

building-large-min-floors  : Min. number of floors for a medium building. (default 5)
building-large-max-floors  : Max. number of floors for a medium building. (default 20

building-small-min-width-m : Min. width of small buildings. (default 15)
building-small-max-width-m : Max. width of small buildings. (default 60)
building-small-min-depth-m : Min. depth of small buildings. (default 10)
building-small-max-depth-m : Max. depth of small buildings. (default 20)

building-medium-min-width-m : Min. width of medium buildings. (default 25)
building-medium-max-width-m : Max. width of medium buildings. (default 50)
building-medium-min-depth-m : Min. depth of medium buildings. (default 20)
building-medium-max-depth-m : Max. depth of medium buildings. (default 50)

building-large-min-width-m : Min. width of large buildings. (default 50)
building-large-max-width-m : Max. width of large buildings. (default 75)
```

```
building-large-min-depth-m : Min. depth of large buildings. (default 50)
building-large-max-depth-m : Max. depth of large buildings. (default 75)

building-texture : The texture used for all buildings. See Docs/buildings.png for
                   details. (default Texture/buildings.png)

building-lightmap: Emissive texture for all buildings, which is faded in at night to
                   provide illusion of lit windows.  Same texture coordinates and
                   format at building-texture above.

building-range-m: Range at which all buildings are visible.  Beyond this point fewer
                  and fewer buildings are rendered, with no buildings rendered at
                  2*building-range-m (default 10000)
```

22 Mingw

```
How to compile FlightGear with mingw
====================================


MinGW & MSYS
============

You need to install mingw & msys:

http://www.mingw.org

You need at least:

MinGW: binutils, gcc-core, gcc-g++, mingw-runtime, mingw-utils, w32api
I would recommed the gcc-3.4.4 versions.
MSYS: msys-1.0.10.exe, msys-autoconf, msys-automake, msys-libtool, msys-DTK.

Please read instructions carefully.

Set the follwing environment variables within msys shell.

export CFLAGS="-I/usr/local/include -O2"
export CXXFLAGS="-I/usr/local/include -O2"
```

```
export CPPFLAGS=-I/usr/local/include
export LDFLAGS=-L/usr/local/lib

Pthread-win32
=============

http://sources.redhat.com/pthreads-win32/

compile:
make  GCE-inlined

Install:
cp pthread.h sched.h semaphore.h /usr/local/include
cp linpthreadGCE2.a  /usr/local/lib/libpthread.a
cp pthread-GCE.dll /usr/local/bin

patch header:

--- pthread.h   Sat Oct  1 20:56:43 2005
***************
*** 210,218 ****
   * -----------------
   */

! #if HAVE_CONFIG_H
! #include "config.h"
! #endif /* HAVE_CONFIG_H */

  #ifndef NEED_FTIME
  #include <time.h>
--- 210,218 ----
   * -----------------
   */

! //#if HAVE_CONFIG_H
! //#include "config.h"
! //#endif /* HAVE_CONFIG_H */

  #ifndef NEED_FTIME
  #include <time.h>
```

```
GLUT
====

use precompiled in order to avoid conflicts with glut32.dll already installed.

http://www.xmission.com/~nate/glut.html
http://www.xmission.com/~nate/glut/glut-3.7.6-bin.zip

The header has to be updated with respect to MINGW.

*** glut.h      Tue Dec 12 22:22:52 2000
--- /local_old/include/GL/glut.h        Thu Aug 18 20:41:15 2005
***************
*** 20,26 ****
     /* XXX This is from Win32's <windef.h> */
  #  ifndef APIENTRY
  #   define GLUT_APIENTRY_DEFINED
! #   if (_MSC_VER >= 800) || defined(_STDCALL_SUPPORTED) || defined(__BORLANDC__) ||
  #    define APIENTRY    __stdcall
  #   else
  #    define APIENTRY
--- 20,26 ----
     /* XXX This is from Win32's <windef.h> */
  #  ifndef APIENTRY
  #   define GLUT_APIENTRY_DEFINED
! #   if (_MSC_VER >= 800) || defined(_STDCALL_SUPPORTED) || defined(__BORLANDC__) ||
  #    define APIENTRY    __stdcall
  #   else
  #    define APIENTRY


install:
cp glut.h /usr/local/include
cp glut32.dll /usr/local/bin

reimp glut32.lib
cp libglut32.a /usr/local/lib

OpenAL
```

```
======

Get OpenAL for instance from Creative

OpenAL win32 package
install Redist


install:

cd libs
reimp  OpenAL32.lib
cp libopenal32.a  /usr/local/lib
cp alut.lib  /usr/local/lib/libalut.a
cd ..
mkdir /usr/local/include/AL
cp Include/* /usr/local/include/AL


zlib-1.2.3
==========

configure --prefix=/usr/local
make
make install

plib-1.6.8
==========
configure --prefix=/usr/local
make
make install

simgear
=======
get simgear from CVS
configure --prefix=/usr/local
make
make  install

flightgear
```

```
=========
configure --prefix=/usr/local --with-threads
make
make install
```

23 Minipanel

```
Mini Panels for c172

List of files:

./keyboard.xml - same as release key bindings with "s" added to swap panels.
./preferences.xml - same as release preferences.xml with "panel2" added.
./Aircraft/c172/Panels/c172-panel-mini.xml - mini with sacred six, compass,
        mixture knob, flaps, and control indicators.
./Aircraft/c172/Panels/c172-panel-trans-mini.xml - same mini panel with
        plexiglass (transparent) background.
./Aircraft/c172/Panels/Textures/panel-mini-bg.rgb - grey background.
./Aircraft/c172/Panels/Textures/panel-trans-mini-bg.rgb - transparent background.


USAGE NOTES:

Hitting "s" will switch between the standard panel and the default.

You may choose other panels for the two that get toggled by changing the
preferences or adding command line parameters.

The property for the panels are:
Normal (Primary) panel: /sim/panel/path=<path to xml file>
Mini (Secondary) panel: /sim/panel2/path=<path to xml file>

The new property is /sim/panel2/path,  it does not need to be a mini panel, you
can use whatever you want.

For example: to use the grey mini panel change preferences.xml or add this to
your command line:
```

```
runfgfs --prop:/sim/panel2/path=Aircraft/c172/Panels/c172-panel-mini.xml
```

24 Multiplayer

```
The commands are of the form:

--multiplay=in | out,Hz,destination address,destination port
--callsign=a_unique_name


Below are some examples of startup commands that demonstrate the use of the
multiplayer facilities.

For two players on a local network or across the internet:
-----------------------------------------------------------
Player1:
--multiplay=out,10,192.168.0.3,5500 --multiplay=in,10,192.168.0.2,5501
--callsign=player1

Player2:
--multiplay=out,10,192.168.0.2,5501 --multiplay=in,10,192.168.0.3,5500
--callsign=player2


For multiple players on a local network:
----------------------------------------
Player1:
--multiplay=out,10,255.255.255.255,5500
--multiplay=in,10,255.255.255.255,5500 --callsign=player1

Playern:
--multiplay=out,10,255.255.255.255,5500
--multiplay=in,10,255.255.255.255,5500 --callsign=playern

Note that the callsign is used to identify each player in a multiplayer game
so the callsigns must be unique. The multiplayer code ignores packets that
are sent back to itself, as would occur with broadcasting when the rx and tx
ports are the same.
```

```
Multiple players sending to a single player:
--------------------------------------------
Player1:
--multiplay=out,10,192.168.0.2,5500 --callsign=player1

Player2:
--multiplay=out,10,192.168.0.2,5500 --callsign=player2

Player3:
--multiplay=out,10,192.168.0.2,5500 --callsign=player3

Player4 (rx only):
--multiplay=in,10,192.168.0.2,5500 --callsign=player4

This demonstrates that it is possible to have multiple instances of
Flightgear that send to a single instance that displays all the traffic. This
is the sort of implementation that we are considering for use as a tower
visual simulator.


For use with a server:
----------------------
Oliver Schroeder has created a server for multiplayer flightgear use.
The server acts as a packet forwarding mechanism. When it
receives a packet, it sends it to all other active players
in the vicinity (the server is configured to use 100nm by default).

Check out the server homepage <http://www.o-schroeder.de/fg_server/>
for the current status. You can either download the server for
some local use, or join the developers flying at the existing servers.
As with flightgear, the server is free software, released under GPL.

Pigeon <http://pigeond.net> has created a web page monitoring
two such servers, showing the traffic in a Google map environment.
See <http://pigeond.net/flightgear/fg_server_map.html>.

Options needed to enable multiplayer game with a server:
Player1:
--multiplay=out,10,serveraddress,5000 --multiplay=in,10,myaddress,5000
```

```
--callsign=player1

Player2:
--multiplay=out,10,serveraddress,5000 --multiplay=in,10,myaddress,5000
--callsign=player2

...

PlayerN:
--multiplay=out,10,serveraddress,5000 --multiplay=in,10,myaddress,5000
--callsign=playerN
```

Note that if every player using a particular server, such as one of those listed on the Pigeon's page, needs to have a unique callsign, not already in use on that server.

If you are sitting behind a NAT'ting firewall, then you need to forward the incoming traffic on the firewall outer (visible to the internet) address arriving at the UDP port you use (5000 in the case above) over to your private LAN address. In this case, use your PRIVATE LAN address as <myaddress>. Example (if your private LAN address is 10.0.0.1, in order to play on pigeond.net):

```
fgfs --multiplay=in,10,10.0.0.1,5000 --multiplay=out,10,pigeond.net,5000
        --callsign=...UNIQUE callsign here...
```

If you and the server are in the same address space (i.e., both have a public IP address or both are on the same private LAN), you hopefully don't need to mess with any firewalls.

If you don't see other players playing on the same server in your flightgear, check that you have followed the above router configuration guidelines. Check that you don't have any LOCAL firewall running on your computer preventing the flightgear network traffic flow.

Finally, use ethereal(1) or tethereal(1) to capture the UDP traffic on the port that you are using, and see if you observe both incoming and outgoing packets.

It's a good idea to talk to the IRC channel #flightgear on irc.flightgear.org while flying on one of the public servers. Also, it makes sense for every user

on the same server to use the same weather setup, e.g., the real weather METAR feed, selected by setting to true the real-world-weather-fetch and control-fdm-atmosphere properties.

Further reading (a must if you have a problem):
---
[1] The flightgear server homepage <http://fgms.sourceforge.net/>
[2] The wiki howto <http://wiki.flightgear.org/index.php/Howto:_Multiplayer>
[3] If everything else fails, ask for help on
the IRC channel #flightgear on irc.flightgear.org

25 Multiscreen

The Open Scene Graph library, which current FlightGear uses for its 3D graphics, provides excellent support for multiple views of a scene. FlightGear uses the osgViewer::Viewer class, which implements a "master" camera with "slave" cameras that are offset from the master's position and orientation. FlightGear provides the "camera group" abstraction which allows the configuration of slave cameras via the property tree.

Slave cameras can be mapped to windows that are open on different screens, or all in one window, or a combination of those two schemes, according to the video hardware capabilities of a machine. It is not advisable to open more than one window on a single graphics card due to the added cost of OpenGL context switching between the windows. Usually, multiple monitors attached to a single graphics card are mapped to different pieces of the same desktop, so a window can be opened that spans all the monitors. This is implemented by Nvidia's TwinView technology and the Matrox TripleHead2Go hardware.

The camera group is configured by the /sim/rendering/camera-group node in the property tree. It can be set up by, among other things, XML in preferences.xml or in an XML file specified on the command line with the --config option.

Here are the XML tags for defining camera groups.

camera-group

For the moment there can be only one camera group. It can contain window, camera, or gui tags.

window
A window defines a graphics window. It can be at the camera-group level or defined within a camera. The window contains these tags:

name - string
The name of the window which might be displayed in the window's title bar. It is also used to refer to a previously defined window. A window can contain just a name node, in which case the whole window definition refers to a previously defined window.

host-name - string
The name of the host on which the window is opened. Usually this is empty.

display - int
The display number on which the window is opened.

screen - int
The screen number on which the window is opened.

x, y - int
The location on the screen at which the window is opened. This is in the window system coordinates, which usually puts 0,0 at the upper left of the screen XXX check this for Windows.

width, height - int
The dimensions of the window.

decoration - bool
Whether the window manager should decorate the window.

fullscreen - bool
Shorthand for a window that occupies the entire screen with no decoration.

camera
The camera node contains viewing parameters.

```
window
This specifies the window which displays the camera. Either it
contains just a name that refers to a previous window definition, or
it is a full window definition.

viewport
The viewport positions a camera within a window. It is most useful
when several cameras share a window.

 x, y - int
 The position of the lower left corner of the viewport, in y-up
 coordinates.

 width, height - int
 The dimensions of the viewport

view
The view node specifies the origin and direction of the camera in
relation to the whole camera group. The coordinate system is +y up,
-z forward in the direction of the camera group view. This is the
same as the OpenGL viewing coordinates.

 x,y,z - double
 Coordinates of the view origin.

 heading-deg, pitch-deg, roll-deg - double
 Orientation of the view in degrees. These are specified using the
 right-hand rule, so a positive heading turns the view to the left,
 a positive roll rolls the view to the left.

perspective
This node is one way of specifying the viewing volume camera
parameters. It corresponds to the OpenGL gluPerspective function.

 fovy-deg - double
 The vertical field-of-view

 aspect-ratio - double
 Aspect ratio of camera rectangle (not the ratio between the
```

vertical and horizontal fields of view).

near, far - double
The near and far planes, in meters from the camera eye point. Note that FlightGear assumes that the far plane is far away, currently 120km. The far plane specified here will be respected, but the sky and other background elements may not be drawn if the view plane is closer than 120km.

offset-x, offset-y - double
Offsets of the viewing volume specified by the other parameters in the near plane, in meters.

frustum
This specifies the perspective viewing volume using values for the near and far planes and coordinates of the viewing rectangle in the near plane.

left, bottom - double
right, top - double
The coordinates of the viewing rectangle.

near, far - double
The near and far planes, in meters from the camera eye point.

ortho
This specifies an orthographic view. The parameters are the sames as the frustum node's.

gui
This is a special camera node that displays the 2D GUI.

viewport
This specifies the position and dimensions of the GUI within a window, *however* at the moment the origin must be at 0,0.

Here's an example that uses a single window mapped across 3 displays. The displays are in a video wall configuration in a horizontal row.

```
<PropertyList>
  <sim>
    <rendering>
      <camera-group>
        <window>
          <name>wide</name>
          <host-name type="string"></host-name>
          <display>0</display>
          <screen>0</screen>
          <width>3840</width>
          <height>1024</height>
          <decoration type = "bool">false</decoration>
        </window>
        <camera>
          <window>
            <name>wide</name>
          </window>
          <viewport>
            <x>0</x>
            <y>0</y>
            <width>1280</width>
            <height>1024</height>
          </viewport>
          <view>
            <heading-deg type = "double">0</heading-deg>
          </view>
          <frustum>
            <top>0.133</top>
            <bottom>-0.133</bottom>
            <left>-.5004</left>
            <right>-.1668</right>
            <near>0.4</near>
            <far>120000.0</far>
          </frustum>
        </camera>
        <camera>
          <window>
            <name type="string">wide</name>
          </window>
          <viewport>
```

```
    <x>1280</x>
    <y>0</y>
    <width>1280</width>
    <height>1024</height>
  </viewport>
  <view>
    <heading-deg type = "double">0</heading-deg>
  </view>
  <frustum>
    <top>0.133</top>
    <bottom>-0.133</bottom>
    <left>-.1668</left>
    <right>.1668</right>
    <near>0.4</near>
    <far>120000.0</far>
  </frustum>
</camera>
<camera>
  <window>
    <name>wide</name>
  </window>
  <viewport>
    <x>2560</x>
    <y>0</y>
    <width>1280</width>
    <height>1024</height>
  </viewport>
  <view>
    <heading-deg type = "double">0</heading-deg>
  </view>
  <frustum>
    <top>0.133</top>
    <bottom>-0.133</bottom>
    <left>.1668</left>
    <right>.5004</right>
    <near>0.4</near>
    <far>120000.0</far>
  </frustum>
</camera>
<gui>
```

```
          <window>
            <name type="string">wide</name>
          </window>
        </gui>
      </camera-group>
    </rendering>
  </sim>
</PropertyList>
```

Here's a complete example that uses a seperate window on each display. The displays are arranged in a shallow arc with the left and right displays at a 45.3 degree angle to the center display because, at the assumed screen dimensions, the horizontal field of view of one display is 45.3 degrees. Each camera has its own window definition; the center window is given the name "main" so that the GUI definition can refer to it. Note that the borders of the displays are not accounted for.

```
<PropertyList>
  <sim>
    <rendering>
      <camera-group>
        <camera>
          <window>
            <host-name type="string"></host-name>
            <display>0</display>
            <screen>0</screen>
            <fullscreen type = "bool">true</fullscreen>
          </window>
          <view>
            <heading-deg type = "double">45.3</heading-deg>
          </view>
          <frustum>
            <top>0.133</top>
            <bottom>-0.133</bottom>
            <left>-.1668</left>
            <right>.1668</right>
            <near>0.4</near>
            <far>120000.0</far>
          </frustum>
```

```
</camera>
<camera>
  <window>
    <name type="string">main</name>
    <host-name type="string"></host-name>
    <display>0</display>
    <screen>1</screen>
    <fullscreen type = "bool">true</fullscreen>
  </window>
  <view>
    <heading-deg type = "double">0</heading-deg>
  </view>
  <frustum>
    <top>0.133</top>
    <bottom>-0.133</bottom>
    <left>-.1668</left>
    <right>.1668</right>
    <near>0.4</near>
    <far>120000.0</far>
  </frustum>
</camera>
<camera>
  <window>
    <host-name type="string"></host-name>
    <display>0</display>
    <screen>2</screen>
    <fullscreen type = "bool">true</fullscreen>
  </window>
  <view>
    <heading-deg type = "double">-45.3</heading-deg>
  </view>
  <frustum>
    <top>0.133</top>
    <bottom>-0.133</bottom>
    <left>-.1668</left>
    <right>.1668</right>
    <near>0.4</near>
    <far>120000.0</far>
  </frustum>
</camera>
```

```
        <gui>
          <window>
            <name type="string">main</name>
          </window>
        </gui>
      </camera-group>
    </rendering>
  </sim>
</PropertyList>
```

26 Osgtext

This document describes the syntax for text objects in the scene graph. Text nodes are configured using XML and may appear within a model description file, like other models or the particlesystem.

For the anxious reader, here is a complete example of a text node:

```
<!-- Must be enclosed by a <text/> node
<text>
  <!-- It should have a name. Can be used for other animations -->
  <name>My first Text</name>
  <!-- Use offsets for the initial placement -->
  <offsets>
    <pitch-deg>0</pitch-deg>
    <heading-deg>0</heading-deg>
    <roll-deg>0</roll-deg>
    <x-m>0</x-m>
    <y-m>0</y-m>
    <z-m>0</z-m>
  </offsets>

  <!-- instead of using pitch/heading/roll offset, one may use
       axis-alignment -->
  <!-- remember: x backwards, y right and z up -->
  <axis-alignment>xy-plane</axis-alignment>
  <!--
  <axis-alignment>reversed-xy-plane</axis-alignment>
  <axis-alignment>xz-plane</axis-alignment>
```

```
<axis-alignment>reversed-xz-plane</axis-alignment>
<axis-alignment>yz-plane</axis-alignment>
<axis-alignment>reversed-yz-plane</axis-alignment>
<axis-alignment>screen</axis-alignment>
-->

<!-- what type of text to draw, use on of literal, text-value or number-value -->
<!-- A simple constant, never changing string -->
<type type="string">literal</type>
<text type="string">Hello, world!</text>

<!-- The string value of a property -->
<type type="string">text-value</type>
<property type="string">some/property</property>
<format type="string">%s</format> <!-- the printf() format to display the value -->

<!-- A number from a property -->
<type type="string">number-value</type>
<property type="string">position/latitude-deg</property>
<factor type="double">1.0</factor> <!-- optional, scale the propertie's value -->
<offset type="double">0.0</offset> <!-- optional, shift the propertie's value -->
<format type="string">%5.2lf</format> <!-- printf() format to display -->
<truncate type="bool">false</truncate> <!-- truncate to an integer value -->

<layout>left-to-right</layout> <!-- default -->
<!--
<layout>right-to-left</layout>
<layout>vertical</layout>
-->

<draw-text type="bool">true</draw-text> <!-- draw the text itself -->
<draw-alignment type="bool">false</draw-alignment> <!-- draw crosshair at object ce
<draw-boundingbox type="bool">false</draw-boundingbox> <!-- draw a bounding box -->

<font>led.txf</font> <!-- The font file name, relative to data/Fonts -->
<character-size type="double">0.01</character-size> <!-- size (height) im meters --
<character-aspect-ratio type="double">1.0</character-aspect-ratio>
<max-height>0.012</max-height> <!-- the maximum height of the text -->
<max-width>0.040</max-width> <!-- the maximum width of the text -->
<font-resolution>
```

```
    <width type="int">32</width>
    <height type="int">32</height>
  </font-resolution>

  <!-- chose one of the kerning types or omit for default -->
  <kerning>default</kerning>
  <!--
  <kerning>unfitted</kerning>
  <kerning>none</kerning>
  -->

  <alignment>center-center</alignment> <!-- alignment of the text itself -->
  <!-- possible values are
  <alignment>left-top</alignment>
  <alignment>left-center</alignment>
  <alignment>left-bottom</alignment>
  <alignment>center-top</alignment>
  <alignment>center-center</alignment>
  <alignment>center-bottom</alignment>
  <alignment>right-top</alignment>
  <alignment>right-center</alignment>
  <alignment>right-bottom</alignment>
  <alignment>left-baseline</alignment>
  <alignment>center-baseline</alignment>
  <alignment>right-baseline</alignment>
  <alignment>baseline</alignment>
  -->

</text>

The <text/> node may appear within <model/> or <PropertyList/> nodes. If you place
your text directly within your model file, use <text></text> nodes. You can also put
your <text> configuration into a separate file using the well known include directive

Your model.xml file:
<model>
  <path>may-fancy-model.ac</path>
  <text include="HelloWorld.xml"/>
</model>
```

```
Your HelloWorld.xml:
<PropertyList>
  <name>Hello World</name>
  <font>Helvetica.txf</font>
  <type type="string">literal</type>
  <text type="string">Hello, world!</text>
  <!-- etc. - you get the idea -->
</PropertyList>

Animation can be applied to text nodes like any other object. To give your text some
color, use the material animation, or translate, rotate, scale or spin your text as
you like.
```

27 Properties

```
================================================================================
CONTROLS
================================================================================

Flight Controls
---------------
/controls/flight/aileron
/controls/flight/aileron-trim
/controls/flight/elevator
/controls/flight/elevator-trim
/controls/flight/rudder
/controls/flight/rudder-trim
/controls/flight/flaps
/controls/flight/slats
/controls/flight/BLC                    // Boundary Layer Control
/controls/flight/spoilers
/controls/flight/speedbrake
/controls/flight/wing-sweep
/controls/flight/wing-fold
/controls/flight/drag-chute

Engines
-------
/controls/engines/throttle_idle
```

```
/controls/engines/engine[%d]/throttle
/controls/engines/engine[%d]/starter
/controls/engines/engine[%d]/fuel-pump
/controls/engines/engine[%d]/fire-switch
/controls/engines/engine[%d]/fire-bottle-discharge
/controls/engines/engine[%d]/cutoff
/controls/engines/engine[%d]/mixture
/controls/engines/engine[%d]/propeller-pitch
/controls/engines/engine[%d]/magnetos
/controls/engines/engine[%d]/boost
/controls/engines/engine[%d]/WEP
/controls/engines/engine[%d]/cowl-flaps-norm
/controls/engines/engine[%d]/feather
/controls/engines/engine[%d]/ignition
/controls/engines/engine[%d]/augmentation
/controls/engines/engine[%d]/afterburner
/controls/engines/engine[%d]/reverser
/controls/engines/engine[%d]/water-injection
/controls/engines/engine[%d]/condition

Fuel
----
/controls/fuel/dump-valve
/controls/fuel/tank[%d]/fuel_selector
/controls/fuel/tank[%d]/to_engine
/controls/fuel/tank[%d]/to_tank
/controls/fuel/tank[%d]/boost-pump[%d]

/consumables/fuel/tank[%d]/level-lbs
/consumables/fuel/tank[%d]/level-gal_us
/consumables/fuel/tank[%d]/capacity-gal_us
/consumables/fuel/tank[%d]/density-ppg
/consumables/fuel/total-fuel-lbs
/consumables/fuel/total-gal_us


Gear
----
/controls/gear/brake-left
/controls/gear/brake-right
```

```
/controls/gear/brake-parking
/controls/gear/steering
/controls/gear/gear-down
/controls/gear/antiskid
/controls/gear/tailhook
/controls/gear/tailwheel-lock
/controls/gear/wheel[%d]/alternate-extension

Anti-Ice
--------
/controls/anti-ice/wing-heat
/controls/anti-ice/pitot-heat
/controls/anti-ice/wiper
/controls/anti-ice/window-heat
/controls/anti-ice/engine[%d]/carb-heat
/controls/anti-ice/engine[%d]/inlet-heat

Hydraulics
----------
/controls/hydraulic/system[%d]/engine-pump
/controls/hydraulic/system[%d]/electric-pump

Electric
--------
/controls/electric/battery-switch
/controls/electric/external-power
/controls/electric/APU-generator
/controls/electric/engine[%d]/generator
/controls/electric/engine[%d]/bus-tie

Pneumatic
---------
/controls/pneumatic/APU-bleed
/controls/pneumatic/engine[%d]/bleed

Pressurization
--------------
/controls/pressurization/mode
/controls/pressurization/dump
/controls/pressurization/outflow-valve
```

```
/controls/pressurization/pack[%d]/pack-on

Lights
------
/controls/lighting/landing-lights
/controls/lighting/turn-off-lights
/controls/lighting/formation-lights
/controls/lighting/taxi-light
/controls/lighting/logo-lights
/controls/lighting/nav-lights
/controls/lighting/beacon
/controls/lighting/strobe
/controls/lighting/panel-norm
/controls/lighting/instruments-norm
/controls/lighting/dome-norm

Armament
--------
/controls/armament/master-arm
/controls/armament/station-select
/controls/armament/release-all
/controls/armament/station[%d]/stick-size
/controls/armament/station[%d]/release-stick
/controls/armament/station[%d]/release-all
/controls/armament/station[%d]/jettison-all

Seat
----
/controls/seat/vertical-adjust
/controls/seat/fore-aft-adjust
/controls/seat/cmd_selector_valve
/controls/seat/eject[%d]/initiate
/controls/seat/eject[%d]/status

APU
---
/controls/APU/off-start-run
/controls/APU/fire-switch

Autoflight
```

```
----------
/controls/autoflight/autopilot[%d]/engage
/controls/autoflight/autothrottle-arm
/controls/autoflight/autothrottle-engage
/controls/autoflight/heading-select
/controls/autoflight/altitude-select
/controls/autoflight/bank-angle-select
/controls/autoflight/vertical-speed-select
/controls/autoflight/speed-select
/controls/autoflight/mach-select
/controls/autoflight/vertical-mode
/controls/autoflight/lateral-mode

================================================================================
FDM (Aircraft settings)
================================================================================

Position
---------------
/position/latitude-deg
/position/longitude-deg
/position/altitude-ft

Orientation
-----------
/orientation/roll-deg
/orientation/pitch-deg
/orientation/heading-deg

/orientation/roll-rate-degps
/orientation/pitch-rate-degps
/orientation/yaw-rate-degps

/orientation/side-slip-rad
/orientation/side-slip-deg
/orientation/alpha-deg

Velocities
----------
/velocities/airspeed-kt
```

```
/velocities/mach
/velocities/speed-north-fps
/velocities/speed-east-fps
/velocities/speed-down-fps

/velocities/uBody-fps
/velocities/vBody-fps
/velocities/wBody-fps

/velocities/vertical-speed-fps
/velocities/glideslope

Acceleration
------------
/accelerations/nlf

/accelerations/ned/north-accel-fps_sec
/accelerations/ned/east-accel-fps_sec
/accelerations/ned/down-accel-fps_sec

/accelerations/pilot/x-accel-fps_sec
/accelerations/pilot/y-accel-fps_sec
/accelerations/pilot/z-accel-fps_sec

Engines
-------

common:
/engines/engine[%d]/fuel-flow-gph
/engines/engine[%d]/fuel-flow_pph
/engines/engine[%d]/thrust_lb
/engines/engine[%d]/running
/engines/engine[%d]/starter
/engines/engine[%d]/cranking

piston:
/engines/engine[%d]/mp-osi
/engines/engine[%d]/egt-degf
/engines/engine[%d]/oil-temperature-degf
/engines/engine[%d]/oil-pressure-psi
```

```
/engines/engine[%d]/cht-degf
/engines/engine[%d]/rpm

turbine:
/engines/engine[%d]/n1
/engines/engine[%d]/n2
/engines/engine[%d]/epr
/engines/engine[%d]/augmentation
/engines/engine[%d]/water-injection
/engines/engine[%d]/ignition
/engines/engine[%d]/nozzle-pos-norm
/engines/engine[%d]/inlet-pos-norm
/engines/engine[%d]/reversed
/engines/engine[%d]/cutoff

propeller:
/engines/engine[%d]/rpm
/engines/engine[%d]/pitch
/engines/engine[%d]/torque


================================================================================
LIGHT
================================================================================
/sim/time/sun-angle-rad
/rendering/scene/ambient/red
/rendering/scene/ambient/ggreen
/rendering/scene/ambient/blue
/rendering/scene/diffuse/red
/rendering/scene/diffuse/green
/rendering/scene/diffuse/blue
/rendering/scene/specular/red
/rendering/scene/specular/green
/rendering/scene/specular/blue
```

28 Protocol

```
The generic communication protocol for FlightGear provides a powerful way
of adding a simple ASCII based or binary input/output protocol, just by
```

```
defining an XML encoded configuration file and placing it in the
$FG_ROOT/Protocol/ directory.



== file layout ===============================================================

A protocol file can contain either or both of <input> and <output>
definition blocks. Which one is used depends on how the protocol
is called  (e.g. --generic=file,out,1,/tmp/data.xml,myproto would
only use the <output> definitions block).

  <?xml version="1.0"?>
  <PropertyList>
      <generic>

          <output>
              <binary_mode>false</binary_mode>
              <line_separator></line_separator>
              <var_separator></var_separator>
              <preamble></preamble>
              <postamble></postamble>

              <chunk>
                      ... first chunk spec ...
              </chunk>

              <chunk>
                      ... another chunk etc. ...
              </chunk>
          </output>

          <input>
              <line_separator></line_separator>
              <var_separator></var_separator>

              <chunk>
                      ... chunk spec ...
              </chunk>
```

```
          </input>

      </generic>
  </PropertyList>
```

```
== input/output parameters ============================================

Both <output> and <input> blocks can contain information about
the data mode (ascii/binary) and about separators between fields
and data sets, as well as a list of <chunk>s. Each <chunk> defines
a property that should be written (and how), or a variable and which
property it should be written to.

--- ASCII protocol parameters ---

output only:
  <preamble>        STRING  default: ""    file header put on top of the file
  <postamble>       STRING  default: ""    file footer put at the end of the file

input & output:
  <binary_mode>     BOOL    default: false (= ASCII mode)
  <var_separator>   STRING  default: ""    field separator
  <line_separator>  STRING  default: ""    separator between data sets


<var_separator> are put between every two output properties, while
<line_separator> is put at the end of each data set. Both can contain
arbitrary strings or one of the following keywords:

  Name             Character

  newline          '\n'
  tab              '\t'
  formfeed         '\f'
  carriagereturn   '\r'
  verticaltab      '\v'
```

```
Typical use could be:

  <var_separator>tab</var_separator>
  <line_separator>newline</var_separator>

or

  <var_separator>\t</var_separator>
  <line_separator>\r\n</line_separator>


--- Binary protocol parameters ---

To enable binary mode, simply include a <binary_mode>true</binary_mode> tag in
your XML file. The format of the binary output is tightly packed, with 1 byte
for bool, 4 bytes for int, and 8 bytes for double. At this time, strings are not
supported. A configurable footer at the end of each "line" or packet of binary
output can be added using the <binary_footer> tag. Options include the length
of the packet, a magic number to simplify decoding. Examples:

  <binary_footer>magic,0x12345678</binary_footer>
  <binary_footer>length</binary_footer>
  <binary_footer>none</binary_footer>                <!-- default -->



== variable parameters (chunk spec) ==========================================

Both <input> and <output> block can contain a list of <chunk> specs,
each of which describes the properties of on variable to write/read.


  <name>        for ease of use (not tranferred)
  <node>        the property tree node which provides the data
  <type>        the value type (needed for formatting)
                one of string, float, bool, int (default: int)
  <format>      (ASCII protocol only, not used or needed in binary mode)
                defines the actual piece of text which should be sent.
```

```
                it can include "printf" style formatting options like:
                                <type>
                        %s      string
                        %d      integer (default)
                        %f      float

  <factor>      an optional multiplication factor which can be used for
                unit conversion. (for example, radians to degrees).
  <offset>      an optional offset which can be used for unit conversion.
                (for example, degrees Celcius to degrees Fahrenheit).


Chunks can also consist of a single constant <format>, like in:
  <format>Data Section</format>


== examples ========================================================================

Writes log of this form:

V=16
H=3.590505
P=3.59
V=12
H=3.589020
P=3.59



<?xml version="1.0"?>

<PropertyList>
  <generic>

    <output>
      <line_separator>newline</line_separator>
      <var_separator>newline</var_separator>
      <binary_mode>false</binary_mode>

      <chunk>
```

```
        <name>speed</name>
        <format>V=%d</format>
        <node>/velocities/airspeed-kt</node>
      </chunk>

      <chunk>
        <name>heading (rad)</name>
        <format>H=%.6f</format>
        <type>float</type>
        <node>/orientation/heading-deg</node>
        <factor>0.0174532925199433</factor>  <!-- degrees to radians -->
      </chunk>

      <chunk>
        <name>pitch angle (deg)</name>
        <format>P=%03.2f</format>
        <node>/orientation/pitch-deg</node>
      </chunk>
   </output>

 </generic>
</PropertyList>
```

```
-- writing data in XML syntax -------------------------------------------------

Assuming the file is called $FG_ROOT/Protocol/xmltest.xml, then it could be
used as   $ fgfs --generic=file,out,1,/tmp/data.xml,xmltest


<?xml version="1.0"?>

<PropertyList>
  <generic>
    <output>
      <binary_mode>false</binary_mode>
      <var_separator>\n</var_separator>
      <line_separator>\n</line_separator>
```

```
      <preamble>&lt;?xml version="1.0"?&gt;\n\n&lt;data&gt;\n</preamble>
      <postamble>&lt;/data&gt;\n</postamble>

      <chunk>
        <format>\t&lt;set&gt;</format>
      </chunk>

      <chunk>
        <node>/position/altitude-ft</node>
        <type>float</type>
        <format>\t\t&lt;altitude-ft&gt;%.8f&lt;/altitude-ft&gt;</format>
      </chunk>

      <chunk>
        <node>/velocities/airspeed-kt</node>
        <type>float</type>
        <format>\t\t&lt;airspeed-kt&gt;%.8f&lt;/airspeed-kt&gt;</format>
      </chunk>

      <chunk>
        <format>\t&lt;/set&gt;</format>
      </chunk>
    </output>
  </generic>
</PropertyList>


-- Analyzing the resulting binary packet format -------------------------------

A utility called generic-protocol-analyse can be found under
FlightGear/utils/xmlgrep which can be used to analyze the resulting
data packet for the binary protocol.

The output would be something like:

bintest.xml
Generic binary output protocol packet description:

 pos | size |  type  | factor     | description
-----|------|--------|------------|------------------------
```

```
  0 |    4 |    int |            | indicated speed (kt)
  4 |    4 |  float |            | pitch att (deg)
  8 |    4 |  float |            | magnetic heading (deg)
 12 |    4 |    int |            | outside air temperarure (degF)
 16 |    1 |   bool |            | autocoord

total package size: 17 bytes
```

29 Scenery

This document describes how FlightGear searches and loads scenery, how to add static objects to the scenery as well as the syntax of *.stg files.

Contents ----------

1 scenery path

FlightGear loads scenery by default from the Scenery/ subdirectory of its data directory. The path to this data directory can be set via environment variable FG_ROOT or the --fg-root option. The scenery path can be set independently via environment variable FG_SCENERY or option --fg-scenery. The order of precedence is as follows:

```
--fg-scenery=/some/dir          ... highest priority
$FG_SCENERY
$FG_ROOT/Scenery/               ... lowest priority
```

A scenery specification may be a list of paths, separated by the OS-specific path separator (colon on Unix/OSX, semicolon on MS Windows). The paths are searched in the order from left to right:

```
FG_SCENERY=/first/dir:/second/dir:/third/dir
                                    (likewise with --fg-scenery option)
```

Each of the scenery paths can follow one of two possible layouts: with or without Terrain/ and Objects/ subdirectories. As soon as either or both of these subdirectories are found, scenery is only searched *in* these two, but not in any other directory on the same hierarchy level!

This example shows which directories are used to search for scenery:

```
$ ls /first/dir
w130n30/                    searched

$ ls /second/dir
Objects/                    searched
Terrain/                    searched
```

```
  w130n30/                    *not* searched

  $ ls /third/dir
  Terrain/                    searched
  w130n30/                    *not* searched
```

If FlightGear searches for a particular "tile" file, let's say for "w130n30/w123n37/942050.stg", then (using the above examples) it looks into

```
  /first/dir/w130n30/w123n37/942050.stg             (A)

  /second/dir/Terrain/w130n30/w123n37/942050.stg    (B)\__ same path element
  /second/dir/Objects/w130n30/w123n37/942050.stg    (C)/      /second/dir

  /third/dir/Terrain/w130n30/w123n37/942050.stg     (D)
```

but as soon as it finds an OBJECT_BASE entry it only finishes this path element and then stops scanning. So, if (B) contains an entry "OBJECT_BASE 942050.btg, then the twin Objects/ directory (C) will be read, too. But (D) will *not*! Objects/ and Terrain/ directories are laid out equally. Airport and elevation data, as well as airport inventory objects are usually put into Terrain/, while other objects are put into Objects/.

This searching behavior is usually used to collect user-added custom objects first, then to read in standard scenery and objects that came with the distribution (San Francisco Bay area), and to use locally added scenery everywhere else. So a typical scenery path specification could look like this:

```
  FG_SCENERY=$HOME/.fgfs/Scenery:$FG_ROOT/Scenery:$FG_ROOT/WorldScenery
```

The third path would then be populated by the user with unpacked scenery archives downloaded from http://www.flightgear.org/Downloads/scenery.html, or by using terrasync (see next section).
Additional objects can be downloaded from the FlightGear Objects Database (http://scenemodels.flightgear.org/download/). (Note that those objects are occasionally merged into the flightgear.org/terrasync

packages, so you may end up with doubled entries!)

Using a private directory for downloaded add-on scenery and adding
that path to FG_SCENERY is the preferred way. This separates default
data from locally added data, and makes administration and later updates
easier.

HINT: if you want to see where FlightGear is searching and finding
terrain/objects, start it with the --log-level=info option.

2 terrasync ----------

FlightGear comes with a utility "terrasync" that allows downloading
scenery (literally) "on-the-fly. Given the scenery path setup from
section 1 you could use terrasync with a script like this:

```
#!/bin/bash
PORT=5503
nice terrasync -p $PORT -d $FG_ROOT/WorldScenery&
fgfs --atlas=socket,out,1,localhost,$PORT,udp $*
killall terrasync
```

If you name it "fgfsterra", then you can use it just like you would use
"fgfs", but behind the scenes it would update your scenery everywhere in
sight and save the files to $FG_ROOT/WorldScenery. Example:

```
$ ./fgfsterra --aircraft=ufo --airport=LOXZ
```

Note, however, that if it downloads scenery for the area around your
starting location, then you'll only see that after the next start, or
after you flew or teleported to a distant location and then back.
terrasync depends on the rsync application and an open port 873,
so it may not be available/usable on MS Windows.

3 stg files

stg files ("static terragear") define the static elements of a scenery "tile", including the terrain elevation data, airport geometry, and all static objects placed on this tile. (See section 5 for how to find out which geo coordinates belong to which tile.) Four of the available key words are followed by a string and four numbers. The meaning of these numbers is always the same and described in section 3.3.

3.1 OBJECT_BASE

specifies the terrain elevation data file. These files are generated with the TerraGear tools (http://www.terragear.org/) and have file extension ".btg" ("binary terragear"; there used to be an "*.atg" file, too, where the 'a' stood for ASCII).

Example:

```
OBJECT_BASE 942050.btg
```

The entry may be anywhere in the 942050.stg file, on a separate line.

3.2 OBJECT

specifies an airport geometry 'drop-in' file. The scenery elevation file has cut out holes for airports, that are filled with such objects. They are usually called after the airport ICAO id:

Example:

```
  OBJECT KSFO.btg
```

These files are, again, created by TerraGear tools and are usually gzipped,
so you'll find that file stored as KSFO.btg.gz.

3.3 OBJECT_SHARED

add static object to the tile.

Example:

```
  OBJECT_SHARED Models/Airport/tower.xml -122.501090 37.514830 15.5 0.00 0.00 0.00
```

Syntax:

```
  OBJECT_SHARED <object-path> <lon> <lat> <elev-m> <hdg-deg> <pitch-deg> <roll-deg>
```

The <object-path> is relative to the data directory (FG_ROOT).
<elev-m> is in meter and relative to mean sea-level (in the fgfs world).
<hdg-deg> is in degree, counter-clockwise with North being 0.0. Note
that this differs from about every other place in FlightGear, most notably
the /orientation/heading-deg entry in the property system, which is clockwise.
<pitch-deg> and <roll-deg> are in degree and optional.
OBJECT_SHARED models are cached and reused. They are only once in memory
and never freed. (See also the next section.)

3.4 OBJECT_STATIC

add static objects to the tile, just like OBJECT_SHARED. There are three
differences to OBJECT_SHARED (apart from the name):

(A) the path is relative to the tile directory where the *.stg file with

this entry is located. For example, relative to 130n30/w123n37/. This usually means that all 3D object files, textures, and XML animation files are in this tile directory, too.

(B) these objects are *not* cached and kept loaded, but rather freed with the tile (that is, when you leave that area).

(C) the animation XML files may contain Nasal blocks <nasal><load> and <nasal><unload> which are executed on loading/unloading.

Example:

```
OBJECT_STATIC ggb-fb.xml -122.4760494 37.81876042 0 105 0.00 0.00
```

3.5 OBJECT_SIGN

defines taxiway or runway sign. The syntax is much like that of OBJECT_SHARED entries, except that the path is replaced with a sign contents specification and that there is an additional size value at the end of the line.

Example:

```
OBJECT_SIGN {@R}10L-28R{@L}C -122.35797457 37.61276290 -0.5398 74.0 2
```

The sign specification defines the sign contents. We try to resemble the apt.dat 850 specifications in our implementation.
In the simplest form it contains just 'normal' text, for example:

```
EXIT
```

This will create a black panel of 1m height with "EXIT" written on it in white versal letters. Actually, each of those characters are single-letter glyph names that are looked up in the <glyph> map of a texture font <material> entry in $FG_ROOT/materials.xml. It just happens that the <glyph> entry for <name> 'E' maps to a drawn 'E' in the font texture. This isn't true for all ASCII characters. Many aren't

mapped at all (and thus not available), others are mapped to non-standard drawings. The '_', for example, is mapped to an empty black area and can therefore be used as a space. (The sign specification must not contain real spaces.) The '*' is mapped to a raised period.

Some glyph names consist of more than one character, and can't, thus, be used directly. They have to be put in a pair of curly braces:

```
{^rd}
```

This creates an arrow that points to the right and down. Braces can really contain a list of glyph names, separated by commas (no space!). Single-letter glyph names can be used that way, too, or in any mixture of both methods:

```
EXIT
{E,X,I,T}
{E}{X}{I}{T}
EX{I,T}
E{X,I}T{^lu,^rd}
{^u}EXIT{^u}
```

Multi-letter glyph names are usually used for symbols. Arrow symbol names always start with a caret ("arrow head") and the left or right direction always comes first (like the x in a Cartesian coordinate system). Here's a list of some of the available names (see $FG_ROOT/materials.xml for more):

```
^l       left arrow
^r       right arrow
^u       up arrow
^d       down arrow
^lu      left-up arrow
^ld      left-down arrow
^ru      right-up arrow
^rd      right-down arrow
no-entry "no entry" symbol
critical runway critical area
```

```
  safety   ils safety area
  hazard   end of taxiway


There are commands for pre-defined sign types according to the FAA
specification (5345-44; see http://www.google.com/search?q=5345-44g).

  @Y   "Direction, Destination, Boundary" sign (black on yellow)
  @R   "Mandatory Instruction" sign (white on red with black outline)
  @L   "Location" sign  (yellow text and frame on black)
  @B   "Runway Distance Remaining" sign  (white on black)


Examples:

  {@R}10L-28R{@L}C
  {@Y,^l}P|{^lu}N{@L}F{@Y}F{^ru}
  {@Y,^ld}C   ...  same as any of {@Y}{@ld}C  {@Y,@ld,C}
  {@B}17


Syntax errors are reported in --log-level=debug, in the SG_TERRAIN
group. You can use this command line to filter out such messages:

  $ fgfs --log-level=debug 2>&1|grep OBJECT_SIGN




4 model manager ("/models/model") ------------------------------------------


4.1  static objects
-------------------

Another way to add objects to the scenery is via the "model manager".
It reads all /models/model entries at startup and places these objects
in the scenery. Just load a definition like the following into the
```

property tree, for example by putting it into $FG_ROOT/preferences.xml, or
better: an XML file that you load with e.g. --config=$HOME/.fgfs/stuff.xml:

```
  <models>
      <model n="0">
          <name>pony</name>
          <path>Local/pony.ac</path>
          <longitude-deg>-115.8352869</longitude-deg>
          <latitude-deg>37.24302849</latitude-deg>
          <elevation-ft>4534.691321</elevation-ft>
          <heading-deg>0</heading-deg>
          <pitch-deg>0</pitch-deg>
          <roll-deg>0</roll-deg>
      </model>
  </models>
```

The <path> is relative to $FG_ROOT, the <name> is optional. One can leave the
heading/pitch/roll entries away, in which case they are set to zero. The values
are fixed and unchangeable at runtime.

4.2 dynamic objects

Any of the model properties can be made changeable at runtime by appending
"-prop" and using a property path name instead of the fixed value:

```
  <local>
      <pony>
          <longitude-deg>-115.8352869/<longitude-deg>
          <latitude-deg>37.24302849</latitude-deg>
          <elevation-ft>4534.691321</elevation-ft>
          <heading-deg>0</heading-deg>
      </pony>
  </local>

  <models>
      <model n="1">
```

```
          <name>pony</name>
          <path>Local/pony.ac</path>
          <longitude-deg-prop>/local/pony/longitude-deg</longitude-deg-prop>
          <latitude-deg-prop>/local/pony/latitude-deg</latitude-deg-prop>
          <elevation-ft-prop>/local/pony/elevation-ft</elevation-ft-prop>
          <heading-deg-prop>/local/pony/heading-deg</heading-deg-prop>
          <pitch-deg>1.234</pitch-deg>  <!-- static, just for fun -->
      </model>
  </models>
```

Then one can move the pony around by changing the values in /local/pony/ in the property system. One can, of course, use other animals, too.

4.3 loading/unloading at runtime

Both dynamic and static model-manager-models can be loaded and unloaded at runtime. For loading you first create a new <model> entry under <models>, initialize all properties there (<longitude-deg> or <longitude-deg-prop>, etc.), and finally you create a child <load> of any type in this group. This is the signal for the model manager to load the object. You can remove the <load> property after that. It has no further meaning.

To remove a model-manager model at runtime, you simply delete the whole <model> group.

5 tools for object placing

5.1 calc-tile.pl

For finding out the tile number for a given geo coordinate pair there's

a script "scripts/perl/scenery/calc-tile.pl" in the FlightGear sources.
You feed longitude and latitude to it and it returns the path to the
*.stg file where you have to add the object entry.

```
$ perl calc-tile.pl 16.1234 48.5678
Longitude: 16.1234
Latitude:  48.5678
Tile:      3220128
Path:      "e010n40/e016n48/3220128.stg"
```

5.2 ufo scenery object editor

The ufo has a scenery object editor built-in. It uses the model manager
described in section 4. To place objects with it, start fgfs, optionally
with specifying an initial model type ("cursor") and a list of subdirectories
of $FG_ROOT where the ufo should search for available 3D models ("source"):

```
$ fgfs --aircraft=ufo --prop:cursor=Models/Airport/radar.xml  \
                      --prop:source=Models,Scenery/Objects
```

Then click anywhere on the terrain to add a model (left mouse button).
You can open the adjustment dialog (Tab-key) to make adjustments to
position and orientation. Click as often as you like, choose further
models from the space-key dialog. You can select an already placed object
by Ctrl-clicking at its base (not at the object itself, but the surface
point where it's located!). By also holding the Shift key down, you
can select several objects or add them to a selection. You can remove
the selected object(s) with the Backspace-key. (See the ?-key dialog
for futher available keys.) After clicking on the input field right
over the status line (invisible if there's no text in it) you can enter
a comment/legend for the selected object.

And finally, you dump the object data to the terminal (d-key) or export
them to a file $HOME/.fgfs/ufo-model-export.xml (Unix) or
%APPDATA%\flightgear.org\ufo-model-export.xml (MS Windows).

You can now put the generated object entries into the specified *.stg
file to make them permanent. Or load the whole exported *.xml file
via --config option:

```
  $ fgfs --config=$HOME/.fgfs/ufo-model-export.xml
```

If you choose the sign placeholder object from the m-key dialog (first
entry; "Aircraft/ufo/Models/sign.ac"), then an OBJEC_SIGN *.stg line
will be generated with the legend used as sign contents. If you didn't
insert any legend, then the sign text will be: NO CONTENTS and a 4 digits
random number for later identification in the *.stg file.

Unfortunately, objects added with this method are kept in memory, no
matter where you are actually flying, so the *.stg method is preferable.

6 embedded Nasal in XML files (static objects and AI) ----------

6.1 static models

Objects loaded via OBJECT_STATIC in *.stg files as well as AI models loaded
via scenarios may contain embedded Nasal code. This can be used to drive
more advanced animations. An example is a lighthouse with specific light
signals, or hangar doors that open when the "player"'s aircraft is nearby.
The Nasal code is added to the object's XML wrapper/animation file, anywhere
on the top level, for example:

```
   <PropertyList>
       <path>lighthouse.ac</path>

       <nasal>
           <load>
               var loop_id = 0;
               var light = aircraft.light.new("
```

```
                    "/models/static/w120n30/w118n35/lighthouse/light",
                    [2, 1, 2, 1, 2, 1, 2, 5]);

            var loop = func(id) {
                id == loop_id or return;
                light.switch(getprop("/sim/time/sun-angle-rad") > 1.37);
                settimer(func { loop(id) }, 30);
            }
            loop(loop_id += 1);
        </load>

        <unload>loop_id += 1</unload>
    </nasal>

    <animation>
        <type>select</type>
        <object-name>light-halo</object-name>
        <property>/models/static/w120n30/w118n35/lighthouse/light/state</property>
    </animation>

    ...
</PropertyList>
```

The <load> part is executed when the scenery tile on which the model is placed is loaded into memory. It can start timers or listeners that modify properties, which are then queried by the <animation>. As a convention developers are requested to use "/models/static/" + <tile-path> + <file-basename>. So, in the above example file "$FG_ROOT/Scenery/Objects/w120n30/w118n35/lighthouse.xml" all properties are stored under "/models/static/w120n30/w118n35/lighthouse/". That way collisions with other models are quite unlikely.

An optional <unload> part is executed when the tile and model is removed from memory. Note that this is only when the "player" is already far away! To cause minimal impact on the framerate it is recommended to do as few calculations as possible, to use as large timer intervals as possible, and to stop all timers and listeners in the <unload> part, as shown in the example.

All Nasal variables/functions are in a separate namespace, which is named after the file name. It's recommended not to access this namespace from

outside for other than development purposes.

What the above code does: as soon as the model is loaded, an aircraft.light is created with a specific light sequence. Then, in half-minute intervals, the light is turned on or off depending on the sun angle. On <unload> the loop identifier is increased, which makes the loop terminate itself. For more info about this technique, see the Nasal wiki.

6.2 AI models

Here the syntax is the same like for static models. The only two differences are:

- these models are currently only removed at program end, so it's more important to consider effects on performance.

- AI models don't need to store their properties in /models/static/..., but get a separate node under /ai/models/, for example /ai/models/carrier[1]. The embedded Nasal code can access this dynamically assigned property via cmdarg() function, which returns a props.Node hash. Example:

```
<nasal>
    <load>print("my data are under ", cmdarg().getPath())</load>
    <unload>print("Currently I'm only called at fgfs exit!")</unload>
</nasal>
```

30 Sound

OpenAL setup for general use (Linux)

As of the July 2004 release of OpenAL it is best to add at least the

following line to your ~/.openalrc file on Linux because it wil find out what audio backend to use, starting with the most appropriate:

```
(define devices '(native alsa sdl esd arts null))
```

ALSA surround sound (5.1) setup

(taken from http://floam.ascorbic.com/how-to/alsa5.1)

Make a ~/.openalrc, we are telling OpenAL that we want surround sound and we want to use ALSA instead of OSS.

```
(define speaker-num 4)
(define devices '(alsa))
(define alsa-out-device "surround40:0,0")
```

IRIX surround sound (5.1) setup

To add 4 channel surround sound on IRIX hardware that supports in directly you can just add the following line to your ~/.openalrc file:

```
(define speaker-num 4)
```

To add 4 channel surround sound to IRIX systems that have more than one stereo output you can add the following section to your ~/.openalrc file (for a typical O2 configuration):

```
(define speaker-num 4)
(define native-out-device "Analog Out")
(define native-rear-out-device "Analog Out 2")
```

or alternatively:

```
(define speaker-num 4)
(define native-out-device "A3.Speaker")
(define native-rear-out-device "A3.LineOut2")
```

(Note the following section is obsolete as of the July 2004 release of
OpenAL, since your could command OpenAL to use ALSA or Arts directly)

ALSA and Arts

I'm using kernel 2.6.5 with alsa, my sound module is snd-intel8x0. When I ran
fgfs, I'd get quite 'choppy' sound (wasn't smooth, there'd be a couple of
breaks in the sound every second or so). Running arts, and starting fgfs with
"artsdsp fgfs" (from the artsdsp website: "When an application is run under
artsdsp all accesses to the /dev/dsp audio device are intercepted and mapped
into aRts API calls. While the device emulation is not perfect, most
applications work this way, albeit with some degradation in performance and
latency.") would improve the situation, but it seemed to still be choppy.

This command:
echo "fgfs 0 0 direct" >/proc/asound/card0/pcm0p/oss

(from the alsa kernel OSS emulation website:
  "The direct option is used, as mentioned above, to bypass the automatic
   conversion and useful for MMAP-applications")

made my sound work beautifully when fgfs was run with artsdsp. Running without
artsdsp however (with artsd suspended or killed), would give me no sound at all
(which I find a bit strange)

The following websites might help people with similar troubles:
http://www.alsa-project.org/~iwai/OSS-Emulation.html
http://www.arts-project.org/doc/handbook/artsdsp.html

Computer info:

kernel 2.6.5

flightgear 0.9.4
simgear 0.3.5
plib 1.8.3

```
soundcard is onboard an asus p4p800-e deluxe mobo (using snd-intel8x0), alsa,
related modules from lsmod:
Module                  Size  Used by
snd_pcm_oss            53252  1
snd_mixer_oss          19968  1 snd_pcm_oss
snd_intel8x0           33476  1
snd_ac97_codec         63492  1 snd_intel8x0
snd_pcm                97408  2 snd_pcm_oss,snd_intel8x0
snd_timer              26112  1 snd_pcm
snd_page_alloc         11396  2 snd_intel8x0,snd_pcm
snd_mpu401_uart         7936  1 snd_intel8x0
snd_rawmidi            24832  1 snd_mpu401_uart
snd_seq_device          8324  1 snd_rawmidi
snd                    53892  9 snd_pcm_oss,snd_mixer_oss,snd_intel8x0,
                                snd_ac97_codec,snd_pcm,snd_timer,snd_mpu401_uart,
                                snd_rawmidi,snd_seq_device
soundcore              10208  2 snd
```

31 Submodels

```
<?xml version="1.0"?>

<!--

Submodels are objects which can be dropped or launched from the user
aircraft. The trigger is a boolean property, which you define, which when
"true" causes the submodel to be released/launched.

A submodel will create an AIBallistic object which will follow a ballistic
path. By default one submodel will be released when the corresponding
trigger is "true".

Notes:
   1.  This utility is intended for ballistic objects which align to the
   trajectory. Drag is applied based on this assumption: no allowance is
   for changes in drag for objects which do not conform to this asumption.
   made
```

2. While Inertia is calculated properly, Moment of Inertia and rotational aerodynamic damping are simulated. It is assumed that the object is a cylinder of uniform density - if your object does not conform to this, there will be inaccuracies.

3. The program does not calculate windage for ballistic objects well. While adequate for smoke effects, etc., for bullets, bombs, droptanks this is probably best left at "False". Since the effects of wind on various ballistic objects is uncertain, there is no plan to change this situation.

4. Submodels can be ensted to any depth, thus a submodel on expiry or impact etc, can launch a child submodel, which in turn can launch a submodel. and so on. This is the basis for Persistent Contrails, but any use is possible.

The initial conditions (IC) define the object's starting point (relative to the user aircraft's "reported position"), and its initial speed and direction (relative to the user aircraft). If you want to release many similar objects with similar IC, then you may use the <repeat>, <delay> and <count> properties to define this. The allowed properties are:

<name>	The name of the submodel.
<model>	The path to the visual model.
<trigger>	The property which will act as the trigger. If this tag is not included, the submodels will be released continuously, provided <count> is set to -1.
<speed>	Initial speed, in feet/sec, relative to user aircraft.
<speed-prop>	The property containing the Initial speed, in feet/sec, relative to user aircraft. If this path is found, <speed> will be overwritten.
<repeat>	Set "true" if you want multiple releases of this submodel.
<delay>	Time, in seconds, between repeated releases.
<count>	Number of submodels available for multiple release. -1 defines an unlimited number.
<slaved>	If true, the submodel is slaved to the parent model.
<x-offset>	Submodel's initial fore/aft position (in feet), relative to user aircraft. Fore is positive.
<y-offset>	Submodel's initial left/right position (in feet), relative to user aircraft. Right is positive.
<z-offset>	Submodel's initial up/down position (in feet), relative to user aircraft. Up is positive.
<yaw-offset>	Submodel's initial azimuth, in degrees, relative to user

aircraft'snose. Right is positive.

<pitch-offset> Submodel's initial elevation, in degrees, relative to user aircraft's pitch. Up is positive.

<life> Life span in seconds.
Default is 900.0.

<buoyancy> In ft/sec/sec. Works opposite acceleration of gravity.
For example, if set to 32 the submodel will feel no
gravity. If greater than 32 the object will rise.
Default is 0.

<wind> Set to true if you want the submodel to react to the wind. Default is "false".

<cd> The Coeffient of Drag. Varies with submodel shape - 0.295 for a bullet, 0.045 for an airfoil. Enter an appropriate value. Defaults to 0.295.

<random> When this is true the Cd is varied by +- 5%. Useful for smoke or contrails.

<eda> Effective drag area (sq ft). Usually the cross-sectional area of the submodel normal to the airflow.

<weight> The weight of the submodel (lbs). NOT set to 0 on submodel release. You may wish to set this value to 0 by means of key bindings or Nasal script. Defaults to 0.25.

<contents> The path to the contents of a submodel. The contents must be in lbs. Intended for use with drop tanks. The property value will be set to 0 on release of the submodel: do not also set to 0 elsewhere e.g. in key bindings. Defaults to 0.

<random> Varies CD by +- 10%, initial azimuth by +- 10 degs, and life by <randomness>

<randomness> If <random> is true, <randomness> is applied to <life>. 0 > Value < 1 are valid. Defaults to 0.5.

<no-roll> If true the submodel does not roll.

<impact> If true, the impact location (lat/lon) on the terrain is calculated. The Material (e.g Grass)of the terrain, load resistance, and impact velocity. Altitude agl is calculated.

<collision> If true, collisions with other objects is tested. If a collision is detected then the position data are written to the "Report Node".

<fuze-range> Used in detecting collisions. The distance in feet between an object and a submodel at which a collision is deemed to have occurred.

<expiry> If true, the current position of the submodel is written to the "Report Node" when the submodel life expires.

<impact-reports> Defines a "Report Node". When an impact happens, then the path of

```
                the submodel will be written to this node. An attached listener
                function can evaluate the impact properties. If unset, reports go to
                /ai/models/model-impact.

***** experimental ****

<external-force> If true the submodel is subjected to an external force
<force-path> A string describing the property where the magnitude, azimuth and
             elevation of the external force are to be found. The following child
              properties are instantiated:
               ~/force-lb
              ~/force-azimuth-deg
              ~/force-elevation-deg

You will have to set these values by some means (Nasal script etc.) to make use of th
utility.

<PropertyList>

  <submodel>
    <name>left gun</name>
    <model>Models/Geometry/tracer.ac</model>
    <trigger>ai/submodels/submodel[0]/trigger</trigger>
    <speed>2750.0</speed>
    <repeat>true</repeat>
    <delay>0.25</delay>
    <count>100</count>
    <x-offset>1.0</x-offset>
    <y-offset>-7.0</y-offset>
    <z-offset>-2.0</z-offset>
    <yaw-offset>0.4</yaw-offset>
    <pitch-offset>1.8</pitch-offset>
    <life>2.0</life>
  </submodel>

  <submodel>
    <name>right gun</name>
    <model>Models/Geometry/tracer.ac</model>
    <trigger>ai/submodels/submodel[0]/trigger</trigger>
    <speed>2750.0</speed>
```

```
  <repeat>true</repeat>
  <delay>0.25</delay>
  <count>100</count>
  <x-offset>1.0</x-offset>
  <y-offset>7.0</y-offset>
  <z-offset>-2.0</z-offset>
  <yaw-offset>-0.4</yaw-offset>
  <pitch-offset>1.8</pitch-offset>
  <life>2.0</life>
</submodel>

<submodel>
  <name>droptank-l</name>
  <model>Aircraft/Hunter/Models/droptank-100gal.ac</model>
  <trigger>controls/armament/station[0]/jettison-all</trigger>
  <speed>0</speed>
  <repeat>false</repeat>
  <count>1</count>
  <x-offset>0.820</x-offset>
  <y-offset>-9.61</y-offset>
  <z-offset>-2.39</z-offset>
  <yaw-offset>0</yaw-offset>
  <pitch-offset>0</pitch-offset>
  <wind>false</wind>
  <eda>2.11348887</eda>
  <weight>170</weight>
  <cd>0.045</cd>
  <contents>consumables/fuel/tank[2]/level-lbs</contents>
</submodel>

<submodel>
  <name>droptank-r</name>
  <model>Aircraft/Hunter/Models/droptank-100gal.ac</model>
  <trigger>controls/armament/station[1]/jettison-all</trigger>
  <speed>0</speed>
  <repeat>false</repeat>
  <count>1</count>
  <x-offset>0.820</x-offset>
  <y-offset>9.61</y-offset>
  <z-offset>-2.39</z-offset>
```

```
    <yaw-offset>0</yaw-offset>
    <pitch-offset>0</pitch-offset>
    <wind>false</wind>
    <eda>2.11348887</eda>
    <weight>170</weight>
    <cd>0.045</cd>
    <contents>consumables/fuel/tank[3]/level-lbs</contents>
  </submodel>

  <submodel>
    <name>engine exhaust r</name>
    <model>Aircraft/seahawk/Models/exhaust_s.xml</model>
    <trigger>sim/ai/aircraft/exhaust</trigger>
    <speed-node>engines/engine/n1</speed-node>
    <speed>10</speed>
    <repeat>true</repeat>
    <delay>0.1</delay>
    <count>-1</count>
    <x-offset>-3.5</x-offset>
    <y-offset>2.6768</y-offset>
    <z-offset>-0.3937</z-offset>
    <yaw-offset>170</yaw-offset>
    <life>10</life>
    <buoyancy>128</buoyancy>
    <aero-stabilised>0</aero-stabilised>
    <wind>true</wind>
    <eda>1</eda>
    <cd>0.95</cd>
    <weight>1</weight>
    <random>1</random>
  </submodel>

</PropertyList>

-->
```

32 Systems

By Default systems are initialized by the Aircraft/generic/generic-system.xml

```
This initializes the following:
- The generic electrical system
- 1 pitot system, index [0]
- 1 static system index [0]
- 2 vacuum systems [0] and [1], depending on engine rpm of engine[0] and
  engine[1] respectfully

If you want to define more systems, copy the generic-system file to your
aircraft-name/Systems folder and rename it systems.xml

In your aircraft -set file add the path to the system.xml file:
<sim>
    ....
    <systems>
        ....
        <path>Aircraft/aircraft-name/Systems/systems.xml</path>
        ....
    </systems>
    ....
</sim>


** Adding a second pitot system.
In your systems.xml, you should already have

  <pitot>
    <name>pitot</name>
    <number>0</number>
    <stall-deg>60</stall-deg>           # optionnal, default to 60 degrees
  </pitot>

and you need to add for a pitot system with index 1:

  <pitot>
    <name>pitot</name>
    <number>1</number>
    <stall-deg>60</stall-deg>  #optionnal
  </pitot>

For the any pitot system except for the first (with index 0)
```

```
add in the aircraft -set file (below for index 1):

<systems>
      <pitot n="1">
                <serviceable>1</serviceable>
      </pitot>
</systems>

Of course you can add a third or fourth etc.


** Adding a second static system
Absolutely analog with the pitot system. So add in systems.xml:

  <static>
    <name>static</name>
    <number>1</number>
    <tau>1</tau>
    <type>0</type>                          #optionnal: 0,1 or 2 default is 0
    <error-factor>0.5</error-factor>        #optionnal see below default = 0
  </static>

and in the aircraft -set file:

<systems>
      <static n="1">
                <serviceable>1</serviceable>
      </static>
</systems>

Now you can source your instrumentation relying on static and pitot
pressure (airspeed, altimeter, vertical speed indicator) from different
and independent systems


** The PITOT System

The pitot system measures impact pressure and is basically a tube pointing forward.
Small aircraft have one, small IFR aircraft have one or two (of which at least
one is heated) and larger commercial aircraft have three or even more. In those large
```

```
aircraft the left pitot serves the pilot instruments, the right the co-pilot and
the third system the back-up instruments. This might be different for each type
of aircraft of course.
In Flightgear the pitot system outputs the total pressure to the following property:
/systems/pitot[n]/total-pressure-inhg and
/systems/pitot[n]/measured-total-pressure-inhg
which are the same except at supersonic speeds. For supersonic aircraft use the "meas
property. See also the README.airspeed-indicator.
However it is advised for every aircraft to use the measured property. In future
this will be the property where all the measurement faults are reflected.
the following "measurement failures" are currently applied:
1) decrease of total and measured pressure due to side-slip and angle of attack
2) at 60 deg the pitot tube will stall and the value will fall back to static pressur
3) for the "measured" property only: at Mach>1, a shock wave is assumed in front of t
  pitot tube, decreasing the total pressure.

The stall angle may be (optionally) set to any angle between 0 and 90 deg
(default = 60 deg) like so:
  <pitot>
    <name>pitot</name>
    <number>0</number>
    <stall-deg>45</stall-deg>
  </pitot>

Both the decrease of the pitot pressure and the default stall angle are based on a me
on an AN5812 pitot tube.


** The STATIC system

The static system measures the static pressure. So all influences of airspeed are eli
In real life this is however not always easy. Effects from angle of attack, side-slip
gear extension, engine power setting and airspeed are present and for the aircraft
designer it is not alway easy to find a good position for the static port.
Usually the number of static systems are equal to the number of pitot systems.
In Flightgear there are 3 types of static systems modelled.
Type 0 (default): the perfect sensor. No measurement failures.
Type 1: Dual static ports on the fuselage sides. Side-slip angle influence only. this
Type 2: Static port on the pitot tube. Both angle of attack and side-slip influence.
If you want to use type 1 or 2:
```

```
  <static>
    <name>static</name>
    <number>0</number>
    <tau>0.1</tau>
    <type>1</type>
    <error-factor>0.5</error-factor>
  </static>
The output property /systems/static[n]/pressure-inhg is filtered. Therefore, if you w
the effect of the measurement failure, "tau" should be 0.1 or smaller.
The "error-factor" should be between 0.2 and 0.7. Setting it to 0 equals a "perfect s
A setting of 1 means the whole (projected on static port face) impact pressure is app
This is not realistic as usually there are more than one static pick-up points
and so the pressure increase gets "flattened".
```

33 Tutorials

```
== README.tutorials ========================================================

FlightGear offers a flexible tutorial system, entirely written in the Nasal
language. Tutorials can be started and stopped from the "Help" menu. They are
defined in XML files. Each of them has to be loaded into /sim/tutorials/ under
a separate tutorial[n]/ branch:

  <sim>
      <tutorials>
          <tutorial include="Tutorials/take-off.xml"/>
          <tutorial include="Tutorials/landing.xml"/>
      </tutorial>
  </sim>

Alternatively, all tutorials can be defined in one file, with <tutorial> tags
around each tutorial. This is then included like so:

  <sim>
      <tutorials include="foo-tutorials.xml"/>
  </sim>

Finally, tutorials are automatically generated from any valid checklists
on startup.  See README.checklists for details.
```

```
== TUTORIAL STRUCTURE ========================================================


A tutorial has this structure, where some of the elements are described
in detail below:


<tutorial>
  <name>...</name>            mandatory; short identifier, also shown in the
                                         tutorial selection dialog
  <description>...</description> mandatory; longer description for the dialog
  <audio-dir>...</audio-dir>  optional; defines where to load sound samples
  <timeofday>noon</timeofday> optional; defines daytime; any of "dawn",
                                         "morning", "noon", "afternoon",
                                         "evening", "dusk", "midnight", "real"

  <step-time>                 optional; period between each step being executed.
                              Default 5
  <exit-time>                 optional; period between exit/abort conditions being
                              checked. Default 1

  <nasal>
      ...                     optional; initial Nasal code; see below
  </nasal>

  <models>
      ...                     optional; scenery objects; see below
  </models>

  <targets>
      ...                     optional; targets; see below
  </targets>

  <presets>
      ...                     optional; initial simulator state; see below
  </presets>
```

```
<init>                          optional; initial settings; see below
  <set>
      ...                         optional; property settings; allowed multiple
  </set>                          times
  <view>
      ...                         optional; view settings
  </view>
  <marker>
      ...                         optional; marker coordinates
  </marker>
  <nasal>
      ...                         optional; Nasal code
  </nasal>
</init>

<step>                          mandatory; well, not really, but if there's not
                                at least one <step>, then the whole tutorial
                                won't do anything; see below for details

  <message>...</message>          optional; message to be displayed/spoken when
                                  <step> is entered; allowed multiple times, in
                                  which case one is chosen at random

  <audio>...</audio>              optional; file name of *.wav sample to be played;
                                            may be used multiple times (random)
  <set>
      ...                         optional; allowed several times
  </set>
  <view>
      ...                         optional
  </view>
  <marker>
      ...                         optional
  </marker>
  <nasal>
      ...                         optional; Nasal code that is executed when the
  </nasal>                                  step is entered

  <wait>10</wait>                 optional; wait period after initial messages etc.
```

```
    <error>                     optional; allowed several times
        <message>..</message>       optional; text displayed/spoken
        <audio>...</audio>          optional; name of *.wav sample to be played

        <condition>
            ...                     optional, but one should be there to make sense
        </condition>                            see $FG_ROOT/Docs/README.conditions

        <nasal>
            ...                     optional; Nasal code that is executed when the
        </nasal>                                error condition was fulfilled
    </error>

    <exit>                      optional; defines when to leave this <step>
        <condition>                         see $FG_ROOT/Docs/README.conditions
            ...
        </condition>

        <nasal>
            ...                     optional; Nasal code that is executed when the
        </nasal>                                exit condition was met
    </exit>
  </step>


  <end>                           optional; final settings & actions; see below
      <message>...</message>          optional; multiple times (random)
      <audio>...</audio>              optional; multiple times (random)
      <set>
          ...                       optional
      </set>
      <view>
          ...                       optional
      </view>
      <nasal>
          ...                       optional
      </nasal>
  </end>
</tutorial>
```

After the tutorial has finished initialization, it goes through all <steps>. For each it outputs the <message> or <audio>, optionally sets a <marker> and/or a <view>, then it checks all <error>s and, if an <error><condition> is fulfilled, outputs the respective <error><message>. If none of the <error>s occurred, then it checks if the <exit><condition> is true, and if so, it jumps to the next <step>. Otherwise the current <step> is endlessly repeated. Finally, after all <step>s were processed, the <end> group is executed.

== ELEMENTS ==========

-- <nasal> ----------

Embedded Nasal is supported on the top level, in <init> in each <step>, in a <step>'s <error> and <exit>, and in <end>. All Nasal runs in a separate namespace __tutorial, so it's possible to define a function in the <init>'s Nasal block, and to use this function in other blocks without prefix. The namespace is preloaded with some functions:

```
next([n=1])      ... to switch n <step>s forward
previous([n=1])  ... to switch n <step>s backwards

say(what [, who="copilot [, delay=0]])
                 ... says 'what' with voice 'copilot' after 'delay' seconds
```

A Nasal group looks like this:

```
<nasal>
    <script>
```

```
        say("Hi, I'm the pilot!", "pilot");
    </script>
    <module>__tutorial</module>           optional; preset with __tutorial
  </nasal>
```

```
-- <models> ------------------------------------------------------------------
```

This loads models into the scenery. It can be used to place, for example, a helicopter landing pad at an airport where normally none is, so that the tutorial can train landing. The layout is the following, with <path> being relative to $FG_ROOT:

```
  <models>
    <model>
        <path>Models/Airport/supacat_winch.ac</path>     mandatory
        <longitude-deg>-122.4950109</longitude-deg>      mandatory
        <latitude-deg>37.51403798</latitude-deg>         mandatory
        <elevation-ft>51</elevation-ft>                  mandatory
        <heading-deg>2.488888979</heading-deg>           optional (default: 0)
        <pitch-deg>0</pitch-deg>                         optional (default: 0)
        <roll-deg>0</roll-deg>                           optional (default: 0)
    </model>

    <model>
        ...                       another model
    </model>
  </models>
```

The models are only removed before a new tutorial is loaded. Otherwise they remain in the scenery for the whole FlightGear session. They aren't permanently added.

```
-- <targets> ------------------------------------------------------------------
```

These are simple pairs of longitude/latitude under an arbitrary name (here "hospital" and "helipad"):

```
  <targets>
      <hospital>
          <longitude-deg>-122.4950109</longitude-deg>      mandatory
          <latitude-deg>37.51403798</latitude-deg>         mandatory
      </hospital>

      <helipad>
          ...
      </helipad>
  </targets>
```

The tutorial system will for each calculate how the user's aircraft is positioned relative to the respective target, and offer the information in this structure:

```
  <sim>
      <tutorials>
          <targets>
              <hospital>
                  <direction-deg>12.345</direction-deg>
                  <heading-deg>33.333</heading-deg>
                  <distance-m>12404.932</distance-m>
                  <eta-min>39.2358</eta-min>
              </hospital>

              <helipad>
                  ...
              </helipad>
          </targets>
      </tutorials>
  </sim>
```

Where:

<direction-deg> is an angle between the aircraft's velocity vector and the

azimuth to the target. 0 means that the aircraft is moving right towards the target. 10 means that the target is slightly to the right, -90 means that it's exactly left, and -180 or 179.9999 that it's right behind.

<heading-deg> is the absolute heading that the aircraft would currently have to fly with in a straight line to reach the target

<distance-m> is the distance in meters

<eta-min> is the "Estimated Time of Arrival" given the aircraft's current speed towards the target. Positive times mean that the aircraft is getting nearer to the target and can arrive there in this time given the current speed. It will, of course, only arrive there, if <direction-deg> is zero. A negative number means that the aircraft moves away, or in other words: that in this number of minutes it will be away twice as far.

-- <presets> ----------

These set the initial simulator state. All properties are optional.
The last three entries are to define the position relative to the airport/runway or the longitude/latitude.

```
  <presets>
      <airport-id>KHAF</airport-id>
      <on-ground>1</on-ground>
      <runway>12</runway>
    <!--
      <altitude-ft>122.333</altitude-ft>
      <latitude-deg>37.555</latitude-deg>
      <longitude-deg>1000</longitude-deg>
    -->
      <heading-deg>0</heading-deg>
      <airspeed-kt>0</airspeed-kt>
      <glideslope-deg>0</glideslope-deg>
```

```
    <offset-azimuth>0</offset-azimuth>
    <offset-distance>0</offset-distance>
  </presets>
```

-- <set> ----------

<set> groups can be used in <init>, <step>, and <end>. They set a <property> to a given <value> or to the value that a second <property> points to. They can also reset values that were only temporarily changed for the duration of the tutorial. This is desirable for properties that are saved to the aircraft config file or to ~/.fgfs/autosave.xml.

```
  <set>
      <property>/foo/bar</property>        set /foo/bar to 123
      <value>123</value>
  </set>

  <set>
      <property>/foo/bar</property>        set /foo/bar to value of /test
      <property>/test</property>
  </set>
```

-- <view> ----------

These groups can be used in <init>, <step>, and <end>. They smoothly move the view to a new view position/direction. All parameters are optional. If, for example, only <field-of-view> is set, then the view will only zoom in -- the direction and position will remain the same. This feature is meant for cockpit tutorials, where the pilot's view is directed to some switch or instrument. view-number can be used to switch between different views, i.e. to tower-view, copilot view etc. Default view-number is 0 (captain's view).

```
  <view>
      <view-number>0</view-number>                  0=captain's view, 1=copilot,...
      <heading-offset-deg>20</heading-offset-deg>  positive is left
      <pitch-offset-deg>-4</pitch-offset-deg>      positive is up
      <roll-offset-deg>0</roll-offset-deg>         positive is roll right
      <x-offset-m>0.2</x-offset-m>                 positive is move right
      <y-offset-m>0.2</y-offset-m>                 positive is move up
      <z-offset-m>0.2</z-offset-m>                 positive is move back
      <field-of-view>55</field-of-view>            default: 55; smaller zooms in
  </view>                                                       bigger zooms out
```

-- <marker> ----------

These are supported in <init>, <step>, and <end>. They show a magenta colored circle at given position (relative to aircraft origin) in given size. See the last section for how to conveniently find the proper coordinates.

```
  <marker>
      <x-m>1.3</x-m>                               positive is back
      <y-m>0.3</y-m>                               positive is to the right
      <z-m>0.1</z-m>                               positive is up
      <scale>1.3</scale>                           optional; default: 1
  </marker>
```

For this to work, the aircraft model needs to include the tutorial marker model in its animation xml file:

```
  <PropertyList>
      <path>lightning-f1a.ac</path>

      <model>
          <path>Models/Aircraft/marker.xml</path>
      </model>

      ...
```

```
  </PropertyList>
```

```
-- <message>/<audio> ----------------------------------------------------------

Groups <step> and <end> can have one or more <message> entries, and one or
more <audio> entries. If more are used of a kind, then the tutorial chooses
one at random. If <audio> are available, then the contents are interpreted as
file name of a *.wav sample, which is appended to the <audio-dir> path defined
at the <tutorial> top level (default: "") and played by the tutorial system.
Otherwise the <message> is handed over to the voice system, and synthesized
to speech by the Festival speech synthesizer (if installed). In either
case the chosen <message> is displayed on top of the screen. Neither <message>
nor <audio> are mandatory.

Because one and the same <message> string can be displayed *and* be synthesized,
which can be problematic in some cases, there is a way to specify parts for
either display *or* voice synthesizer:  "{<display part>|<voice part}".
Example:

  <message>Press the {No1|number one} button!</message>

Here, "No1" would be displayed on the screen, but "number one" would be
sent to the speech synthesis system. This can also be used to add
invisible but audible exclamation marks:   "Press the button{|!}"
```

```
-- <condition> ----------------------------------------------------------------

These are explained in detail in $FG_ROOT/Docs/README.conditions. Here's just
one example:

  <condition>
      <less-than>
```

```
        <property>/foo/bar</property>
        <value>12</value>
    </less-than>
</condition>
```

This condition is true when the value of /foo/bar is less than 12, and false otherwise.

== FINDING MARKER COORDINATES ==========

If an aircraft tutorial wants to use the marker, then the aircraft animation file needs to include the marker model (see above). If this is done, then one can use the "marker-adjust" dialog to find the respective <marker> coordinates. Just type this into the "Help->Nasal Console" dialog:

```
tutorial.dialog()
```

Or temporarily add a key binding to the *-set.xml file:

```
<key n="96">
    <name>Backtick</name>
    <desc>Open marker adjust dialog</desc>
    <binding>
        <command>dialog-show</command>
        <dialog-name>marker-adjust</dialog-name>
    </binding>
</key>
```

The dialog allows to move a red cross around, which has the blinking marker circle in the middle. Note that ctrl- and shift-modifiers modulate the slider movements. Ctrl makes positioning coarser, and shift finer. The [Reset]

button moves the marker back to aircraft origin, the [Center] button centers the sliders, and the [Dump] button dumps the marker coordinates to the terminal, for example:

```
  <marker>
      <x-m>1.1425</x-m>
      <y-m>0.1994</y-m>
      <z-m>-0.0844</z-m>
      <scale>2.0489</scale>
  </marker>
```

This just needs to be copied to the tutorial XML file.

34 Wildfire

```
Cellular Automata based wildfire for FlightGear/CVS
---------------------------------------------------

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 *  them under the terms of the GNU General Public License as published by
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 *  Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA

Usage
-----
```

```
A fire is started by calling wild_fire.ignite(pos) where pos is a
valid geo.Coord instance.

Example: starting fires by ctrl+shift+click:

Put this Nasal fragment somewhere where it is run at startup.
(E.g. in a <nasal><MyStuff><script>...</script></MyStuff></nasal>
block in preferences.xml.)

setlistener("/sim/signals/click", func {
  if (__kbd.shift.getBoolValue()) {
    if (__kbd.ctrl.getBoolValue()) {
      var click_pos = geo.click_position();
      wildfire.ignite(click_pos);
    }
  }
});


Configuration properties
------------------------

These properties can be set at runtime, in preferences.xml or in any
other way supported by FlightGear.

/environment/wildfire/enabled : bool
  Enables/disables the whole WildFire module.
  On disable the current state is lost. Can be used to reset WildFire.

/environment/wildfire/share-events : bool
  Enables/disables sending and receiving of fire events over the
  multiplayer network.

/environment/wildfire/fire-on-crash : bool
  If true a fire will start if the aircraft crashes.

/environment/wildfire/report-score : bool
  Report the result of fire fighting.

/environment/wildfire/models/enabled : bool
```

```
  Enables/disables rendering of the 3d models.
  (That is, fire, smoke, soot and foam.)

/environment/wildfire/save-on-exit : bool
  If set the current log of Wildfire events is saved in
  ~/.fgfs/Wildfire/fire_log.xml .

/environment/wildfire/restore-on-startup : bool
  If set Wildfire will load and execute the events in
  ~/.fgfs/Wildfire/fire_log.xml . This recreates the fire state
  as it where when the log was saved.
  NOTE: A long event log or one that covers a long period of time will take
  a a lot of time to recreate.
  Storing and reloading of the CA state, as opposed to the event log, is not
  supported yet.


API
---

ignite : func (pos, source=1)
     pos    - fire location    : geo.Coord
     source - broadcast event? : {0, 1}

   Start a fire.


resolve_water_drop : func (pos, radius, volume, source=1)
     pos    - drop location    : geo.Coord
     radius - drop radius m    : double
     volume - Not used         : double
     source - broadcast event? : {0, 1}

  Extinguishes any fires in the cells within r of pos and
  makes the cells nonflammable.

resolve_retardant_drop : func (pos, radius, volume, source=1) {
     pos    - drop location    : geo.Coord
     radius - drop radius m    : double
     volume - Not used         : double
```

```
     source - broadcast event? : {0, 1}

  Identical to resolve_water_drop.

resolve_foam_drop : func (pos, radius, volume, source=1) {
     pos    - drop location    : geo.Coord
     radius - drop radius m    : double
     volume - Not used         : double
     source - broadcast?       : {0, 1}

  Extinguishes any fires in the cells within r of pos and
  makes the cells nonflammable and foamy.

load_event_log : func (filename, skip_ahead_until=-1)
     filename         - getprop("/sim/fg-home") ~ "/Wildfire/" ~ filename
     skip_ahead_until - skip from last event to this time : double (epoch)
                        fast forward from skip_ahead_until
                        to current time.
       x < last event   - fast forward all the way to current time (use 0).
                          NOTE: Can be VERY time consuming.
       -1               - skip to current time.

  Loads an event log.
  The skip_ahead_until argument can be used for synchronizing a restored
  fire state among multiple players.

save_event_log : func (filename)
     filename         - getprop("/sim/fg-home") ~ "/Wildfire/" ~ filename

  Saves an event log.

print_score = func
  Print a summary of the current wildfire state.


/Anders
```

35 Xmlhud

Users' Guide to FlightGear Hud configuration
December 22 2000
Neetha Girish <neetha@ada.ernet.in>

This document describes the reconfigurable HUD of
FlightGear implemented through XML config files.
The present reconfigurable HUD code uses most of the code
of version 0.6.1 vintage and I have adapted the same to provide
a reconfigurable HUD for fgfs.
Corrections and additions are welcome.

Some History:

Older versions of FGFS had a hard coded display of HUD.
This was a less than ideal state of affairs when it came to
using different aircraft Huds. I remember, somewhere in the 0.6.1 HUD code
it was written that the HUD code is 'presently' hard coded but ideally should
be moved into the aircraft configuration dataset, so that when you choose
an aircraft, its HUD loads.
This implementation make that possible, all you have to do is to
create appropriate 'my_aircraft.xml' files in the HUD directory and
without re-compiling the code you could have 'your_aircraft' HUD, by choosing that
in the .fgfsrc file or as a command line option as described later. Of course,
as of now, I have only implemented those HUD instruments in .xml readable form
as was available in version 0.7.6 + few more used by ADA, Bangalore for our
aircraft carrier take-off/landing simulation studies <www.flightgear.org/projects/ADA
To use the ADA specific reticles/HUD objects, please contact me/ you can figure it ou
yourself by studying the code. All of them are relevant 'only' if you use the conform
climb/dive ladder, since they are all referenced to it.
The rewrite of Hud display code was done using pre and post release v0.7.6 code
allowing for configuration of the hud via XML.

The present Configurable Hud implements the entire functionality of
fgfs HUD (called default HUD) till this date.

Using Default/Custom Hud:

The default HUD location is $FG_ROOT/Huds/Default.

$FG_ROOT is the place on your filesystem where you installed FG
data files. Alternate huds can be specified on the command line
or set as the default in the $HOME/.fgfsrc or $FG_ROOT/preferences.xml
using a property specification. The command line format is as follows:

--prop:/sim/hud/path=Huds/Default/default.xml

The path description shown is relative to $FG_ROOT. An absolute
path may also be used for locations outside $FG_ROOT.
For the custom Hud the path will be Huds/Custom/default.xml

Hud - Implementation:

All of the hud configuration files are XML-encoded property lists.
The root element of each file is always named <PropertyList>. Tags are
always found in pairs, with the closing tag having a slash prefixing
the tag name, i.e </PropertyList>. The top level panel configuration
file is composed of a <name> and zero or more <instruments>.
Instruments are used by including a <"unique_name"> and a <path> to the
instruments configuration file.
Comments are bracketed with <!-- -->.

    Example Top Level Hud Config

```
<PropertyList>
 <name>Default Aircraft Hud</name>
 <instruments>

  <hudladder>                    <!--unique name -->
   <path>Huds/Instruments/Default/hudladder.xml</path>
  </hudladder>

  <hudcard>
   <path>Huds/Instruments/Default/hudcard.xml</path>
  </hudcard>

  <instrlabel>
   <path>Huds/Instruments/Default/instrlabel.xml</path>
  </instrlabel>
```

```
  <fgTBI>
   <path>Huds/Instruments/Default/fgtbi.xml</path>
  </fgTBI>

 </instruments>
</PropertyList>
```

```
The default location for instrument files is $FG_ROOT/Huds/Instruments/Default.
The location for custom instrument files is  $FG_ROOT/Huds/Instruments/Custom.
The location for minimal instrument files is $FG_ROOT/Huds/Instruments/Minimal.
Alternate locations may be specified in the hud configuration, paths
must be absolute to use files outside $FG_ROOT.

About Instrument Placement:

For the sake of simplicity the FGFS HUD overlay is always 640 x 480 res.
so all x/y values for instrument placement should fall within these bounds.
Being an OpenGL program, 0,0 represents the lower left hand corner of the
screen.

Instrument Implementation:

Instruments are defined in separate configuration files.
The Instruments are basically classified into 4 types( Each of them an xml file) :
The Hud Ladder,
The Hud Card,
The Hud Label and
The Turn Bank Indicator
.... (Note that that the earlier HUD classes/objects have been retained)
Newer objects may be instantiated using the above classes, Unless a totally
new object is required).

The Default as well as the Custom directory have the same (in terms of properties)
set of configuration files (but with different values to suit the aircraft).

We have a Base class - Hud Instrument Item.
We derive two more base classes - Instrument Scale and Dual Instrument Item from this
(This implementation owes its existence to all those who wrote the HUD code for 0.6.1
```

The Hud Instrument Label is an instantiable class derived from Hud Instrument Item - for displaying alphanumeric labels (altitude, velocity, Mach no and/or anything else as long you have a call back function to pass the value using the property 'data_source').

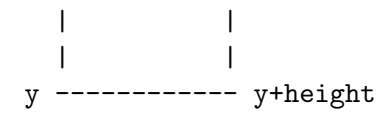
The Hud Card is an instantiable class derived from Instrument scale - for displaying tapes and gauges (single variable display, for displaying aoa, g's, vsi, elevator_posn, etc.).

The Hud Ladder is an instantiable class derived from Dual Instrument Item - for displaying pitch reference ladder or climb/dive ladder (two variable display, for displaying two types of ladders, the pitch reference ladder or the climb/dive ladder as defined by MIL-1787b).

The fgTBI Instrument is an instantiable class derived from Dual Instrument scale again - for display of Bank angle and Sideslip (two variable display, for display of TSI info, kept different from the two variable ladder object basically because of its totally different draw member function).

Most Hud instruments may be instantiated using above. It is proposed to provide all Hud objects as defined in MIL-STD-1797A, soon.

Here is how you position 'any' object:



this defines the objects position centered about the centroid of above rectangle in HUD overlay plane (640x480) coordinates with 0,0 at bottom-left corner.

One more, pixels per degree in the ladder class represents the compression factor of the pitch ladder. In case of conformal HUD (climb/dive ladder) it is <640/horizontal_fov> or <480/vertical_fov>. In case of pitch reference ladder it is <your_no_of vertical_pixels/your_no_of_ladder_degrees>.

Example of Hud Ladder xml file.

```
<PropertyList>

 <ladders>

  <l1>
  <name>Pitch Ladder</name>     <!-- Name can be Pitch Ladder or Climb/Dive Ladder  -
  <x>260</x>                    <!-- x start -->
  <y>150</y>                    <!-- y start -->
  <width>120</width>            <!-- x start + width = x end -->
  <height>180</height>          <!-- y start + height = y end -->
  <compression_factor>2.68</compression_factor>    <!-- Pixels per degree -->
  <loadfn>roll</loadfn>         <!-- Name of the function to be called, here
                                     get_roll() is called provision made in Hud.cxx -
  <loadfn1>pitch</loadfn1>      <!-- Name of the function to be called, here get_pitc
                                     is called -->
  <span_units>45.0</span_units>         <!-- Range of the Ladder seen at any instant
  <division_units>10.0</division_units> <!-- Divisions -->
  <screen_hole>70</screen_hole>         <!-- Hole b/w the Ladder Bars -->
  <lbl_pos>0</lbl_pos>                  <!-- Label Position to indicate pitch angle c
  <enable_frl>false</enable_frl>        <!-- To Enable Pitch Reference Symbol (used b
  <enable_target_spot>true</enable_target_spot>                <!-- To Enable Target
  <enable_velocity_vector>false</enable_velocity_vector>       <!-- To Enable Velocit
  <enable_drift_marker>false</enable_drift_marker>             <!-- To Enable Drift M
  <enable_alpha_bracket>false</enable_alpha_bracket>           <!-- To Enable Alpha B
  <enable_energy_marker>false</enable_energy_marker>           <!-- To Enable Energy
  <enable_climb_dive_marker>false</enable_climb_dive_marker>   <!-- To Enable Climb/D
  <enable_glide_slope_marker>false</enable_glide_slope_marker> <!-- To Enable Glide/S
  <glide_slope>0.0</glide_slope>                               <!-- Glide slope angle
  <enable_energy_worm>false</enable_energy_worm>               <!-- To Enable Energy
  <enable_waypoint_marker>false</enable_waypoint_marker>       <!-- To Enable Way poi
  <working>true</working>                                      <!-- use this to enabl
  </l1>

 </ladders>

</PropertyList>

Before you read this, _____ this is tick_top        |                 |
                            |                       |                 |
                            |                       |_________________|
```

```
                          | this is cap_right,tick_left  cap_bottom    tick_right
                          |
                     _____| this is tick_bottom
```

Example of Hud Card xml file.

```
<PropertyList>

 <cards>

  <c1>
   <name>Gyrocompass</name>
   <x>220</x>
   <y>430</y>
   <width>200</width>
   <height>28</height>
   <loadfn>heading</loadfn>     <!-- Name of the function to be called, here get_Head
   <options>4</options>         <!--  Read Tape Options Below or Hud.hxx file for det
   <maxValue>360.0</maxValue>   <!-- Maximum scale value -->
   <minValue>0.0</minValue>     <!-- Minimum Scale Value -->
   <disp_scaling>1.0</disp_scaling> <!-- Multiply by this to get numbers shown on sca
   <major_divs>5</major_divs>       <!-- major division marker units -->
   <minor_divs>1</minor_divs>       <!-- minor division marker units -->
   <modulator>360</modulator>       <!-- Its a rose, Roll Over Point -->
   <value_span>25.0</value_span>    <!-- Range Shown  -->
   <type>tape</type>                <!-- Card type can be "tape" or "gauge" -->
   <tick_bottom>false</tick_bottom> <!-- Read Ticks and Caps below -->
   <tick_top>false</tick_top>
   <tick_right>true</tick_right>
   <tick_left>true</tick_left>
   <cap_bottom>true</cap_bottom>
   <cap_top>false</cap_top>
   <cap_right>false</cap_right>
   <cap_left>false</cap_left>
   <marker_offset>0.0</marker_offset>    <!-- Read Marker offset below -->
   <enable_pointer>true</enable_pointer> <!-- To draw a pointer -->
   <pointer_type>fixed</pointer_type>    <!-- Type of pointer, Fixed or Moving (yet t
   <working>true</working>
  </c1>
```

```
 </cards>

</PropertyList>

Tape Options:

HUDS_AUTOTICKS    =     0x0001
HUDS_VERT         =     0x0002
HUDS_HORZ         =     0x0000
HUDS_TOP          =     0x0004
HUDS_BOTTOM       =     0x0008
HUDS_LEFT         =     HUDS_TOP
HUDS_RIGHT        =     HUDS_BOTTOM
HUDS_BOTH         =     (HUDS_LEFT | HUDS_RIGHT)
HUDS_NOTICKS      =     0x0010
HUDS_ARITHTIC     =     0x0020
HUDS_DECITICS     =     0x0040
HUDS_NOTEXT       =     0x0080
HUDS_LEFT | HUDS_VERT   = 0x0006
HUDS_RIGHT | HUDS_VERT  = 0x0010
HUDS_TOP | HUDS_NOTEXT  = 0x0084
HUDS_BOTTOM | HUDS_NOTEXT = 0x0088
HUDS_VERT | HUDS_LEFT | HUDS_NOTEXT  = 0x0086
HUDS_RIGHT | HUDS_VERT | HUDS_NOTEXT = 0x0090


For clarity, I repeat, Ticks and Caps :


1. Left Tick ->|_____|<- Right Tick
                  |
                  v
             Bottom Cap

2.    Top Cap
         |
         v
       _____
      |     |
```

```
3.    Top Tick
         |
         v
        ---
           |
           |<- Right Cap
           |
        ---
         |
         v
       Bottom Tick

4.            ---
              |
  Left Cap -> |
              |
              ---
```

Marker Offset :

To Draw pointer on the scale markings. In the case of a our hud with offset 10.0
The pointer is away from the scale and points at the markings.

```
        -|                      -
        -|                      -
        <|                      -<
        -|                      -
        -|                      -
Marker offset = 0.0     Marker offset = 10.0
```

This should be useful when I implement the fixed tape/moving pointer.

Example of a Label xml file.

```
<PropertyList>

 <labels>
```

```
  <i1>
   <name>machno</name>
   <x>25</x>
   <y>130</y>
   <width>40</width>
   <height>30</height>
   <data_source>mach</data_source>    <!-- Name of the function to be called, here ge
   <label_format>%4.2f</label_format> <!-- The Label Format -->
   <pre_label_string>blank</pre_label_string>  <!-- String to be written Pre Label --
   <post_label_string>NULL</post_label_string> <!-- String to be written Post Label -
   <scale_data>1.0</scale_data>
   <options>4</options>               <!-- Read Tape options or Hud.hxx -->
   <justification>2</justification>   <!-- Justify the label, 0=LEFT_JUSTIFY, 1=CENTE
   <blinking>0</blinking>             <!-- Yet to be implemented -->
   <working>true</working>
   <latitude>false</latitude>         <!-- True if the label is to display Latitude
   <longitude>false</longitude>       <!-- True if the label is to display Longitude
  </i1>

 </labels>

</PropertyList>


Example of a Turn Bank Indicator xml file.

<PropertyList>

 <tbis>

  <f1>
  <name>fgTBI_Instrument</name>
  <x>290</x>
  <y>45</y>
  <width>60</width>
  <height>10</height>
  <loadfn>roll</loadfn>       <!-- Name of the function to be called, get_roll() is
  <loadfn1>sideslip</loadfn1> <!-- Name of the function to be called, get_sideslip()
  <maxBankAngle>45.0</maxBankAngle> <!-- Maximum Angle of Bank -->
  <maxSlipAngle>5.0</maxSlipAngle>  <!-- Maximum Angle of Slip -->
```

```
  <gap_width>5</gap_width>          <!-- Screen Hole -->
  <working>true</working>
  </f1>

 </tbis>

</PropertyList>
```

I have still got to implement dials (as in MIL-STD-1787b).

REMEMBER IF YOU NEED TO INDICATE ANY OTHER PARAMETER ON THE HUD OTHER THAN WHAT IS PR
CALLBACK FUNCTIONS (PROPERTY NAMES LISTED BELOW) YOU HAVE TO FIDDLE WITH THE CODE, AS
KNOW AND I SHALL INCLUDE THAT.

```
<loadfn>anzg</loadfn>             <!-- Here get_anzg() is called -->
<loadfn>heading</loadfn>          <!-- Here get_heading() is called -->
<loadfn>aoa</loadfn>              <!-- Here get_aoa() is called -->
<loadfn>climb</loadfn>            <!-- Here get_climb() is called -->
<loadfn>altitude</loadfn>         <!-- Here get_altitude() is called -->
<loadfn>agl</loadfn>              <!-- Here get_agl() is called -->
<loadfn>speed</loadfn>            <!-- Here get_speed() is called -->
<loadfn>view_direction</loadfn>   <!-- Here get_view_direction() is called -->
<loadfn>aileronval</loadfn>       <!-- Here get_aileronval() is called -->
<loadfn>elevatorval</loadfn>      <!-- Here get_elevatorval() is called -->
<loadfn>rudderval</loadfn>        <!-- Here get_rudderval() is called -->
<loadfn>throttleval</loadfn>      <!-- Here get_throttleval() is called -->
<loadfn>aux16</loadfn>            <!-- Here get_aux16() is called -->
<loadfn>aux17</loadfn>            <!-- Here get_aux17() is called -->
<loadfn>aux9</loadfn>             <!-- Here get_aux9() is called -->
<loadfn>aux11</loadfn>            <!-- Here get_aux11() is called -->
<loadfn>aux12</loadfn>            <!-- Here get_aux12() is called -->
<loadfn>aux10</loadfn>            <!-- Here get_aux10() is called -->
<loadfn>aux13</loadfn>            <!-- Here get_aux13() is called -->
<loadfn>aux14</loadfn>            <!-- Here get_aux14() is called -->
<loadfn>aux15</loadfn>            <!-- Here get_aux15() is called -->
<loadfn>aux8</loadfn>             <!-- Here get_aux8() is called -->
<loadfn>ax</loadfn>               <!-- Here get_Ax() is called -->
<loadfn>mach</loadfn>             <!-- Here get_mach() is called -->
<loadfn>framerate</loadfn>        <!-- Here get_frame_rate() is called -->
<loadfn>fov</loadfn>              <!-- Here get_fov() is called -->
```

```
<loadfn>vfc_tris_culled</loadfn>  <!-- Here get_vfc_tris_culled() is called -->
<loadfn>vfc_tris_drawn</loadfn>   <!-- Here get_vfc_tris_drawn() is called -->
<loadfn>latitude</loadfn>         <!-- Here get_latitude() is called -->
<loadfn>longitude</loadfn>        <!-- Here get_longitude() is called -->
```

36 Xmlpanel

Users Guide to FlightGear panel configuration
Version 0.7.7, May 16 2001
Author: John Check <j4strngs@rockfish.net>

This document is an attempt to describe the configuration of FlightGear flight simulator's aircraft panel display via XML. The information was culled from the fgfs-devel@flightgear.org mailing list and my experiences making alternate panels. Corrections and additions are encouraged.

Some History:

Older versions of FGFS had a hard coded display of instruments. This was a less than ideal state of affairs due to FGFS ability to use different aircraft models. Being primarily developed on UNIX type systems, a modular approach is taken towards the simulation. To date, most alternatives to the default Cessna 172 aircraft are the product of research institutions interested in the flight characteristics and not cosmetics. The result of this was that one could fly the X-15 or a Boeing 747 but be limited to C172 instrumentation.

A rewrite of the panel display code was done around v0.7.5 by developer David Megginson allowing for configuration of the panel via XML to address this limitation. Some major changes and additions were made during the course of version 0.7.7 necessitating a rewrite and expansion of this document.

About The Property Manager:

While not absolutely necessary in order to create aircraft panels, some familiarity with the property manager is beneficial.... FlightGear provides a hierarchical representation of all aspects of the state of the running simulation that is known as the property tree. Some properties, such as velocities are read only. Others such as the frequencies to which the navcom radios are tuned or the position of control surfaces can be set by various means. FlightGear can optionally provide an interface to these properties for external applications such as Atlas, the moving map program, or even lowly telnet, via a network socket. Data can even be placed on a serial port and connected to, say a GPS receiver. Aside from its usefulness in a flight training context, being able to manipulate the property tree on a running copy of FG allows for switching components on the fly, a positive boon for panel authors. To see the property tree start FG with the following command line:

```
fgfs --props=socket,bi,5,localhost,5500,tcp
```

Then use telnet to connect to localhost on port 5500. You can browse the tree as you would a filesystem.

XML and the Property Manager:

Panel instruments interface with the property tree to get/set values as appropriate. Properties for which FG doesn't yet provide a value can be created by simply making them up. Values can be adjusted using the telnet interface allowing for creation and testing of instruments while code to drive them is being developed.

If fact, the XML configuration system allows a user to combine

components such as flight data model, aircraft exterior model, heads up display, and of course control panel. Furthermore, such a preconfigured aircraft.xml can be included into a scenario with specific flight conditions. These can be manually specified or a FG session can be saved and/or edited and reloaded later. Options specified in these files can be overridden on the command line. For example:

```
--prop:/sim/panel/path=Aircraft/c172/Panels/c172-panel.xml
```

passed as an option, would override a panel specified elsewhere. Property tree options all have the same format, specify the node and supply it a value.

The order of precedence for options is thus:

Source	Location	Format
command line		
.fgfsrc	Users home directory.	command line options
system.fgfsrc	$FG_ROOT	"" ""
preferences.xml	$FG_ROOT	XML property list

Loading Panels on the fly:

When editing a panel configuration, pressing Shift +F3 will reload the panel. If your changes don't seem to be taking effect, check the console output. It will report the success or failure of the panel reload*. Editing textures requires restarting FGFS so the new textures can be loaded. Panels can be switched on the fly by setting the /sim/panel/path property value and reloading.

Regarding Window Geometry:

For the sake of simplicity the FGFS window is always considered to be 1024x768 so all x/y values for instrument placement should relative to these dimensions. Since FG uses OpenGL 0,0 represents the lower left hand corner of the screen. Panels may have a virtual size larger than 1024x768. Vertical scrolling is accomplished with

Shift+F5/F6. Horizontal scrolling is via Shift+F7/F8. An offset should be supplied to set the default visible area. It is possible to place items to overlap the 3D viewport.

Panel Architecture:

All of the panel configuration files are XML-encoded* property lists. The root element of each file is always named <PropertyList>. Tags are almost always found in pairs, with the closing tag having a slash prefixing the tag name, i.e </PropertyList>. The exception is the tag representing an aliased property. In this case a slash is prepended to the closing angle bracket. (see section Aliasing)

The top level panel configuration file is composed of a <name>, a <background> texture and zero or more <instruments>.Earlier versions required instruments to have a unique name and a path specification pointing to the instruments configuration file.

[Paths are relative to $FG_ROOT (the installed location of FGFS data files.)]
[Absolute paths may be used.Comments are bracketed with <!-- -->.]

Old style instrument call in top level panel.xml:

```
  <clock>         <!-- required "unique_name" -->
   <path>Aircraft/c172/Instruments/clock.xml</path>
   <x>110</x>     <!-- required horizontal placement -->
   <y>320</y>     <!-- required vertical placement -->
   <w>72</w>      <!-- optional width specification -->
   <h>72</h>      <!-- optional height specification -->
  </clock>
```

The difference between the old and new styles, while subtle, is rather drastic. The old and new methods are indeed incompatible. I cover the old style only to acknowledge the incompatibility. This section will be removed after the next official FGFS release.

New Style Example Top Level Panel Config:

```
<PropertyList>
 <name>Example Panel</name>
```

```
 <background>Aircraft/c172/Panels/Textures/panel-bg.rgb</background>
 <w>1024</w>                      <!-- virtual width -->
 <h>768</h>                       <!-- virtual height -->
 <y-offset>-305</y-offset>        <!-- hides the bottom part -->
 <view-height>172</view-height>   <!-- amount of overlap between 2D panel
                                       and 3D viewport -->

 <instruments>                    <!-- from here down is where old and new
                                       styles break compatibility -->

  <instrument include="../Instruments/clock.xml">
   <name>Chronometer</name>   <!-- currently optional but strongly recommended -->
   <x>150</x>                 <!-- required horizontal placement -->
   <y>645</y>                 <!-- required vertical placement -->
   <w>72</w>                  <!-- optional width specification -->
   <h>72</h>                  <!-- optional height specification -->
  </instrument>

 </instruments>

</PropertyList>


Indexed Properties
------------------
This is a lot to do with the compatibility break so lets get it out of
the way.  The property manager now assigns incremental indices to
repeated properties with the same parent node, so that

 <PropertyList>
 <x>1</x>
 <x>2</x>
 <x>3</x>
 </PropertyList>

shows up as

 /x[0] = 1
 /x[1] = 2
 /x[2] = 3
```

```
This means that property files no longer need to make up a separate
name for each item in a list of instruments, layers, actions,
transformations, or text chunks. In fact, the new panel I/O code now
insists that every instrument have the XML element name "instrument",
every layer have the name "layer", every text chunk have the name
"chunk", every action have the name "action", and every transformation
have the name "transformation" -- this makes the XML more regular (so
that it can be created in a DTD-driven tool) and also allows us to
include other kinds of information (such as doc strings) in the lists
without causing confusion.

Inclusion:
----------
The property manager now supports file inclusion and aliasing.
Inclusion means that a node can include another property file as if it
were a part of the current file.  To clarify how inclusion works,
consider the following examples:

If bar.xml contains

 <PropertyList>
 <a>1</a>
 <b>
 <c>2</c>
 </b>
 </PropertyList>

then the declaration

 <foo include="../bar.xml">
 </foo>

is exactly equivalent to

 <foo>
 <a>1</a>
 <b>
 <c>2</c>
 </b>
```

```
 </foo>
```

However, it is also possible to selectively override properties in the included file. For example, if the declaration were

```
 <foo include="../bar.xml">
 <a>3</a>
 </foo>
```

then the property manager would see

```
 <foo>
 <a>3</a>
 <b>
 <c>2</c>
 </b>
 </foo>
```

with the original 'a' property's value replaced with 3.

This new inclusion feature allows property files to be broken up and reused arbitrarily -- for example, there might be separate cropping property lists for commonly-used textures or layers, to avoid repeating the information in each instrument file.

Aliasing

Properties can now alias other properties, similar to a symbolic link in Unix. When the target property changes value, the new value will show up in the aliased property as well. For example,

```
 <PropertyList>
 <foo>3</foo>
 <bar alias="/foo"/>
 </PropertyList>
```

will look the same to the application as

```
 <PropertyList>
```

```
 <foo>3</foo>
 <bar>3</bar>
 </PropertyList>
```

except that when foo changes value, bar will change too.

The combination of inclusions and aliases is very powerful, because it allows for parameterized property files. For example, the XML file for the NAVCOM radio can include a parameter subtree at the start, like this:

```
 <PropertyList>
 <params>
 <comm-freq-prop>/radios/comm1/frequencies/selected</comm-freq-prop>
 <nav-freq-prop>/radios/nav1/frequencies/selected</comm-freq-prop>
 </params>

 ...

 <chunk>
 <type>number-value</type>
 <property alias="/params/nav-freq-prop"/>
 </chunk>

 ...
 </PropertyList>
```

Now, the same instrument file can be used for navcomm1 and navcomm2, for example, simply by overriding the parameters at inclusion:

```
 <instrument include="../Instruments/navcomm.xml">
 <params>
 <comm-freq-prop>/radios/comm1/frequencies/selected</comm-freq-prop>
 <nav-freq-prop>/radios/nav1/frequencies/selected</comm-freq-prop>
 </params>
 </instrument>

 <instrument include="../Instruments/navcomm.xml">
 <params>
```

```
 <comm-freq-prop>/radios/comm2/frequencies/selected</comm-freq-prop>
 <nav-freq-prop>/radios/nav2/frequencies/selected</comm-freq-prop>
 </params>
 </instrument>

Instrument Architecture:
------------------------
Instruments are defined in separate configuration files. An instrument
consists of a base width and height, one or more stacked layers, and
zero or more actions. Base dimensions are specified as follows:

<PropertyList>                    <!-- remember, all xml files start like this -->
 <name>Airspeed Indicator</name> <!-- names are good -->
 <w-base>128</w-base>             <!-- required width spec-->
 <h-base>128</h-base>             <!-- required height spec-->
  <layers>                        <!-- begins layers section -->

Height and width can be overriden in the top level panel.xml by
specifying <w> and <h>. Transformations are caculated against the base
size regardless of the display size. This ensures that instruments
remain calibrated

Textures:
--------
FG uses red/green/blue/alpha .rgba files for textures. Dimensions for
texture files should be power of 2 with a maximum 8:1 aspect ratio.
The lowest common denominator for maximum texture size is 256 pixels.
This is due to the limitations of certain video accelerators, most
notably those with 3Dfx chipset such as the Voodoo2.

Instrument Layers**:
-------------------
The simplest layer is a <texture>. These can be combined in <switch> layers

<texture>
A texture layer looks like this:

  <layer>                       <!-- creates a layer -->
   <name>face</name>
   <texture>                    <!-- defines it as a texture layer -->
```

```
   <path>Aircraft/c172/Instruments/Textures/faces-2.rgb</path>
   <x1>0</x1>                <!-- lower boundary for texture cropping-->
   <y1>0.51</y1>             <!-- left boundary  for texture cropping-->
   <x2>0.49</x2>             <!-- upper boundary  for texture cropping-->
   <y2>1.0</y2>              <!-- right boundary  for texture cropping-->
  </texture>                 <!-- closing texure tag -->
 </layer>                    <!-- closing layer tag -->
```

The texture cropping specification is represented as a decimal. There is a table at the end of this document for converting from pixel coordinates to percentages.

This particular layer, being a gauge face has no transformations applied to it. Layers with that aren't static *must* include <w> and <h> parameters to be visible.

<type> May be either text or switch..

<type>switch</type>
A switch layer is composed of two or more nested layers and will display one of the nested layers based on a boolean property. For a simple example of a switch see $FG_ROOT/Aircraft/c172/Instruments/brake.xml.

```
 <layer>
  <name>Brake light</name>
  <type>switch</type>                    <!-- define layer as a switch -->
  <property>/controls/brakes</property>  <!-- tie it to a property -->
   <layer1>                              <!-- layer for true state -->
    <name>on</name>                      <!-- label to make life easy -->
    <texture>                            <!-- layer1 of switch is a texture layer --
    <path>Aircraft/c172/Instruments/Textures/brake.rgb</path>
    <x1>0.25</x1>
    <y1>0.0</y1>
    <x2>0.5</x2>
    <y2>0.095</y2>
    </texture>
    <w>64</w>                          <!-- required width - layer isn't static -->
    <h>24</h>                          <!-- required height - layer isn't static -->
   </layer1>                           <!-- close layer1 of switch -->
```

```
   <layer2>                              <!-- layer for false state -->
    <name>off</name>
    <texture>
    <path>Aircraft/c172/Instruments/Textures/brake.rgb</path>
    <x1>0.0</x1>
    <y1>0.0</y1>
    <x2>0.25</x2>
    <y2>0.095</y2>
    </texture>
    <w>64</w>
    <h>24</h>
   </layer2>
  </layer>
```

Switches can have more than 2 states. This requires nesting one switch inside another. One could make, for example, a 3 color LED by nesting switch layers.

<type>text</type>
A text layer may be static, as in a label, generated from a property or a combination of both. This example is a switch that contains both static and dynamic text:

```
 <layer1>                           <!-- switch layer -->
  <name>display</name>
  <type>text</type>                 <!-- type == text -->
  <point-size>12</point-size>       <!-- font size -->
  <color>                           <!-- specify rgb values to color text -->
   <red>1.0</red>
   <green>0.5</green>
   <blue>0.0</blue>
  </color>                          <!-- close color section -->
  <chunks>                          <!-- sections of text are referred to as chunks -->
   <chunk>                          <!-- first chunk of text -->
    <type>number-value</type>       <!-- value defines it as dynamic -->
    <property>/radios/nav1/dme/distance</property>    <!-- ties it to a property -->
    <scale>0.00053995680</scale>  <!-- convert between statute and nautical miles? --
    <format>%5.1f</format>          <!-- define format -->
   </chunk>
  </chunks>
```

```
 </layer1>
 <layer2>                          <!-- switch layer -->
  <name>display</name>
  <type>text</type>                <!-- type == text -->
  <point-size>10</point-size>      <!-- font size -->
  <color>                          <!-- specify rgb values to color text -->
   <red>1.0</red>
   <green>0.5</green>
   <blue>0.0</blue>
  </color>                         <!-- close color section -->
  <chunks>                         <!-- sections of text are referred to as chunks -->
   <chunk>                         <!-- first chunk of text -->
    <type>literal</type>           <!-- static text -->
    <text>---.--</text>            <!-- fixed value -->
   </chunk>
  </chunks>
 </layer2>
```

Transformations:

A transformation is a rotation, an x-shift, or a y-shift. Transformations can be static or they can be based on properties. Static rotations are useful for flipping textures horizontally or vertically. Transformations based on properties are useful for driving instrument needles. I.E. rotate the number of degrees equal to the airspeed. X and y shifts are relative to the center of the instrument. Each specified transformation type takes an <offset>. Offsets are relative to the center of the instrument. A shift without an offset has no effect. For example, let's say we have a texure that is a circle. If we use this texture in two layers, one defined as having a size of 128x128 and the second layer is defined as 64x64 and neither is supplied a shift and offset the net result appears as 2 concentric circles.

About Transformations and Needle Placement:

When describing placement of instrument needles, a transformation

offset must be applied to shift the needles fulcrum or else the needle
will rotate around it's middle. The offset will be of <type> x-shift
or y-shift depending on the orientation of the needle section in the
cropped texture.

This example comes from the altimeter.xml

```
  <layer>
   <name>long needle (hundreds)</name>  <!-- the altimeter has more than one needle -
   <texture>
    <path>Aircraft/c172/Instruments/Textures/misc-1.rgb</path>
    <x1>0.8</x1>
    <y1>0.78125</y1>
    <x2>0.8375</x2>
    <y2>1.0</y2>
   </texture>
   <w>8</w>
   <h>56</h>
   <transformations>                    <!-- begin defining transformations -->
    <transformation>                    <!-- start definition of
                                             transformation that drives the needle --
     <type>rotation</type>
     <property>/steam/altitude</property>  <!-- bind it to a property -->
     <max>100000.0</max>                <!-- upper limit of instrument -->
     <scale>0.36</scale>                <!-- once around == 1000 ft -->
    </transformation>                   <!-- close this transformation -->
    <transformation>                    <!-- shift the fulcrum of the needle -->
     <type>y-shift</type>               <!-- y-shift relative to needle -->
     <offset>24.0</offset>              <!-- amount of shift -->
    </transformation>
   </transformations>
  </layer>
```

This needles has its origin in the center of the instrument. If the
needles fulcrum was towards the edge of the instrument, the
transformations to place the pivot point must precede those which
drive the needle,

Interpolation

Non linear transformations are now possible via the use of
interpolation tables.

```
 <transformation>
 ...
 <interpolation>
 <entry>
 <ind>0.0</ind>            <!-- raw value -->
 <dep>0.0</dep>            <!-- displayed value -->
 </entry>
 <entry>
 <ind>10.0</ind>
 <dep>100.0</dep>
 </entry>
 <entry>
 <ind>20.0</ind>
 <dep>-5.0</dep>
 </entry>
 <entry>
 <ind>30.0</ind>
 <dep>1000.0</dep>
 </entry>
 </interpolation>
 </transformation>
```

Of course, interpolation tables are useful for non-linear stuff, as in
the above example, but I kind-of like the idea of using them for
pretty much everything, including non-trivial linear movement -- many
instrument markings aren't evenly spaced, and the interpolation tables
are much nicer than the older min/max/scale/offset stuff and should
allow for a more realistic panel without adding a full equation parser
to the property manager.

If you want to try this out, look at the airspeed.xml file in the base
package, and uncomment the interpolation table in it for a very funky,
non-linear and totally unreliable airspeed indicator.

Actions:

An action is a hotspot on an instrument where something will happen when the user clicks the left or center mouse button. Actions are always tied to properties: they can toggle a boolean property, adjust the value of a numeric property, or swap the values of two properties. The x/y placement for actions specifies the origin of the lower left corner. In the following example the first action sets up a hotspot 32 pixels wide and 16 pixels high. It lower left corner is placed 96 pixels (relative to the defined base size of the instrument) to the right of the center of the instrument. It is also 32 pixels below the centerline of the instrument. The actual knob texture over which the action is superimposed is 32x32. Omitted here is a second action, bound to the same property, with a positive increment value. This second action is placed to cover the other half of the knob. The result is that clicking on the left half of the knob texture decreases the value and clicking the right half increases the value. Also omitted here is a second pair of actions with the same coordinates but a larger increment value. This second pair is bound to a different mouse button. The net result is that we have both fine and coarse adjustments in the same hotspot, each bound to a different mouse button.

These examples come from the radio stack:

```
<actions>                              <!-- open the actions section -->
  <action>                             <!- first action -->
   <name>small nav frequency decrease</name>
   <type>adjust</type>
   <button>0</button>                  <!-- bind it to a mouse button -->
   <x>96</x>                           <!-- placement relative to instrument center -
   <y>-32</y>
   <w>16</w>                           <!-- size of hotspot -->
   <h>32</h>
   <property>/radios/nav1/frequencies/standby</property>    <!-- bind to a property -
   <increment>-0.05</increment>        <!-- amount of adjustment per mouse click -->
   <min>108.0</min>                    <!-- lower range -->
   <max>117.95</max>                   <!-- upper range -->
   <wrap>1</wrap>                      <!-- value wraps around when it hits bounds --
  </action>
  <action>
   <name>swap nav frequencies</name>
   <type>swap</type>                   <!-- define type of action -->
```

```
   <button>0</button>
   <x>48</x>
   <y>-32</y>
   <w>32</w>
   <h>32</h>
   <property1>/radios/nav1/frequencies/selected</property1>   <!-- properties to
   <property2>/radios/nav1/frequencies/standby</property2>         toggle between -->
  </action>
  <action>
   <name>ident volume on/off</name>
   <type>adjust</type>
   <button>1</button>
   <x>40</x>
   <y>-24</y>
   <w>16</w>
   <h>16</h>
   <property>/radios/nav1/ident</property>  <!-- Morse code ID of nav beacons -->
   <increment>1.0</increment>          <!-- the increment equals the max value
                                            so this toggles on/off -->
   <min>0</min>
   <max>1</max>
   <wrap>1</wrap>                      <!-- a shortcut to avoid having separate
                                            actions for on/off -->
  </action>
</actions>
```

More About Textures:

As previously stated, the usual size instrument texture files in FGFS are 256x256 pixels, red/green/blue/alpha format. However the mechanism for specifying texture cropping coordinates is decimal in nature. When calling a section of a texture file the 0,0 lower left convention is used. There is a pair of x/y coordinates defining which section of the texture to use.

The following table can be used to calculate texture cropping specifications.

# of divisions | width in pixels | decimal specification per axis

```
1   =   256 pixels              1
2   =   128 pixels,             0.5
4   =   64 pixels,              0.25
8   =   32 pixels,              0.125
16  =   16 pixels,              0.0625
32  =   8 pixels,               0.03125
64  =   4 pixels,               0.015625
128 =   2 pixels,               0.0078125
```

A common procedure for generating gauge faces is to use a vector graphics package such as xfig, exporting the result as a postscript file. 3D modeling tools may also be used and I prefer them for pretty items such as levers, switches, bezels and so forth. Ideally, the size of the item in the final render should be of proportions that fit into the recommended pixel widths. The resulting files can be imported into a graphics manipulation package such as GIMP, et al for final processing.

How do I get my panels/instruments into the base package?

Cash bribes always help ;) Seriously though, there are two main considerations. Firstly, original artwork is a major plus since you as the creator can dictate the terms of distribution. All Artwork must have a license compatible with the GPL. Artwork of unverifiable origin is not acceptable. Secondly, texture sizes must meet the lowest common denominator of 256e2 pixels. Artwork from third parties may be acceptable if it meets these criteria.

* If there are *any* XML parsing errors, the panel will fail to load, so it's worth downloading a parser like Expat (http://www.jclark.com/xml/) for checking your XML. FlightGear will print the location of errors, but the messages are a little cryptic right now.

** NOTE: There is one built-in layer -- for the mag compass ribbon -- and all other layers are defined in the XML files. In the future, there may also be built-in layers for special things like a weather-radar display or a GPS (though the GPS could be handled with text properties).

37 Xmlparticles

```
Document started 27/01/2008 by Tiago GusmÃ£o
Updated 02/02/2008 to reflect syntax changes
Updated 03/02/2008 to add trails (connected particles)

This is a short specification/tutorial to define particle systems in
FlightGear using XML

Meaningless example (what i had accumulated due to tests):

  <particlesystem>
    <name>fuel</name>
<!--     <texture>particle.rgb</texture> -->
    <emissive>false</emissive>
    <lighting>true</lighting>

    <offsets>
      <x-m>35</x-m>
      <y-m>-0.3</y-m>
      <z-m>0</z-m>
      <!--<pitch-deg>90</pitch-deg>-->
    </offsets>

    <!--<condition>
      <and>
        <equals>
          <property>engines/engine/smoking</property>
          <value>true</value>
        </equals>
        <less-than>
          <property>position/altitude-agl-ft</property>
          <value>12000</value>
        </less-than>
      </and>
    </condition>-->

    <attach>world</attach>

    <placer>
```

```
  <type>point</type>
</placer>

<shooter>
  <theta-min-deg>84</theta-min-deg>
  <theta-max-deg>86</theta-max-deg>
  <phi-min-deg>-1.5</phi-min-deg>
  <phi-max-deg>1.5</phi-max-deg>
  <speed>
    <value>10</value>
    <spread>2.5</spread>
  </speed>
  <rotation-speed>
    <x-min-deg-sec>0</x-min-deg-sec>
    <y-min-deg-sec>0</y-min-deg-sec>
    <z-min-deg-sec>0</z-min-deg-sec>
    <x-max-deg-sec>0</x-max-deg-sec>
    <y-max-deg-sec>0</y-max-deg-sec>
    <z-max-deg-sec>0</z-max-deg-sec>
  </rotation-speed>
</shooter>

<counter>
  <particles-per-sec>
    <value>1</value>
    <spread>0</spread>
  </particles-per-sec>
</counter>

<align>billboard</align>

<particle>
  <start>
    <color>
      <red>
        <value>0.9</value>
      </red>
      <green>
        <value>0.09</value>
      </green>
```

```
      <blue>
        <value>0.09</value>
      </blue>
      <alpha>
        <value>1.0</value>
      </alpha>
    </color>
    <size>
      <value>0.25</value>
    </size>
  </start>

  <end>
    <color>
      <red>
        <value>1</value>
      </red>
      <green>
        <value>0.1</value>
      </green>
      <blue>
        <value>0.1</value>
      </blue>
      <alpha>
        <value>0.0</value>
      </alpha>
    </color>
    <size>
      <value>4</value>
    </size>
  </end>

  <life-sec>
    <value>10</value>
  </life-sec>

  <mass-kg>0.25</mass-kg>
  <radius-m>0.1</radius-m>
</particle>
```

```
    <program>
      <fluid>air</fluid>
      <gravity type="bool">true</gravity>
      <wind type="bool">true</wind>
    </program>
</particlesystem>

Stick this inside any model XML like it was an animation and it should
work (notice the condition requires wheel on the ground)

Specification:

Note:
<VALUEORPROP/> means you can either specify a property with factor and
offset (result = (prop*factor)+offset ) in the usual way


<particlesystem>  = the base tag
  <type>string</type> = can be "normal" or "trail", normal is the usual quad
                        particles, trail is a string of connected line shapes
                        by default.
  <offsets>  = this places the source of the particles (the emitter) in relation
               to the perhaps already offset model (see model-howto.html for details)
    <x-m>float</x-m>
    <y-m>float</y-m>
    <z-m>float</z-m>
    <pitch-deg>float</pitch-deg>
    <roll-deg>float</roll-deg>
    <heading-deg>float</heading-deg>
  </offsets>
  <condition> = a typical condition that if not true stops particles from being
    ....        emitted (PPS=0)
  </condition>
  <name>string</name> = the name of the particle system (so it can be referenced
                        by normal animations)
  <attach>string</attach> = can be "world" or "local". "world means the particles
                            aren't "physically linked" to the model (necessary for
                            use outside moving models), "local" means the opposite
                            (can be used for static objects or inside moving objects)
  <texture>string</texture> = the texture path relative to the XML file location
```

```
<emissive>bool</emissive> = self-explanatory
<lighting>bool</lighting> = yet to be tested, but seems obvious
<align>string</align> = can be "billboard" or "fixed"
<placer> = where particles are born
  <type>string</type> = can be "sector" (inside a circle), "segments"(user-defined
                        segments) and "point" (default)
  *<radius-min-m>float</radius-min-m> = only for sector, inner radius at which
                                        particles appear
  *<radius-max-m>float</radius-max-m> = only for sector, outer radius at which
                                        particles appear
  *<phi-min-deg>float</phi-min-deg> = only for sector, starting angle of the
                                     slide at which particles appear
  *<phi-max-deg>float</phi-max-deg> = only for sector, ending angle of the slide
                                     at which particles appear
  <segments> = only for segments, encloses sequential points that form segments
    <vertex> = specifies one point, put as many as you want
      <x-m>float</x-m>
      <y-m>float</y-m>
      <z-m>float</z-m>
    </vertex>
    ....
    <vertex>
    ...
    </vertex>
  </segments>
</placer>
<shooter> = the shooter defines the initial velocity vector for your particles
  *<theta-min-deg>float</theta-min-deg> = horizontal angle limits of the particle c
  *<theta-max-deg>float</theta-max-deg>
  *<phi-min-deg>float</phi-min-deg> = vertical angle limits of the particle cone
  *<phi-max-deg>float</phi-max-deg>   for an illustration of theta/phi see
  http://www.cs.clemson.edu/~malloy/courses/3dgames-2007/tutor/web/particles/partic
  <speed-mps> = the scalar velocity (meter per second)
   <VALUEORPROP/> = see note
   *<spread> = the "tolerance" in each direction so values are in the range
               [value-spread, value+spread]
  </speed-mps>
  <rotation-speed> = the range of initial rotational speed of the particles
    *<x-min-deg-sec>float</x-min-deg-sec>
    *<y-min-deg-sec>float</y-min-deg-sec>
```

```
    *<z-min-deg-sec>float</z-min-deg-sec>
    *<x-max-deg-sec>float</x-max-deg-sec>
    *<y-max-deg-sec>float</y-max-deg-sec>
    *<z-max-deg-sec>float</z-max-deg-sec>
  </rotation-speed>
</shooter>
<counter>
  <particles-per-sec>
    <VALUEORPROP/> = see note
    *<spread> = the "tolerance" in each direction so values are in the range
                [value-spread, value+spread]
  </particles-per-sec>
</counter>
<particle> = defines the particle properties
  <start>
    <color> = initial color (at time of emission)
      <red><VALUEORPROP/></red> = color component in normalized value [0,1]
      <green><VALUEORPROP/></green>
      <blue><VALUEORPROP/></blue>
      <alpha><VALUEORPROP/></alpha>
    </color>
    <size> = as above, but for size
      <VALUEORPROP/>
    </size>
  </start>
  <end>
    <color> = final color (at the end of the particle life)
      <red><VALUEORPROP/></red>
      <green><VALUEORPROP/></green>
      <blue><VALUEORPROP/></blue>
      <alpha><VALUEORPROP/></alpha>
    </color>
    <size>
      <VALUEORPROP/>
    </size>
  </end>
  *<life-sec> = the time the particles will be alive, in seconds
    <VALUEORPROP/>
  *</life-sec>
  *<radius-m>float</radius-m> = each particles is physically treated as a sphere
```

```
                                  with this radius
    *<mass-kg>float</mass-kg> = mass in KG
  </particle>
  <program> = defines external forces acting upon a particle
    <fluid>string<fluid> = can be "air" or "water"
    <gravity>bool</gravity> = can be "true" or "false". uses standard gravity
    <wind>bool</wind> = can be "true" or "false". uses user position wind (not the
                        model position, but shouldn't be noticeable, you want to
                        disabled it when using local attach)
  </program>
</particles>

Remarks:
* Don't forget you can use existing animations with particles, so if you want to
  direct or translate the emitter, just use translate, rotate, spin and so on
  (other animations might have interesting effects too I guess)

* Particle XML should be compatible with plib, as the tags will be ignored (you
  might get some warning if you attach them to animations though)

* Try not to use a lot of particles in a way that fills the screen, that will demand
  lots of fill rate and hurt FPS

* If you don't use any properties nor conditions, your particle system doesn't need
  to use a callback a so it's slightly better on the CPU (mostly useful for static mo

* If your particle lifetime is too big you might run out of particles temporarily
  (still being investigated)

* Use mass and size(radius) to adjust the reaction to gravity and wind
  (mass/size = density)

* Although at the moment severe graphical bugs can be seen in the trails,
  they are usable.

* Consider your options correctly! You should consider giving them no initial
  velocity and most important, no spread, otherwise particles will race and the
  trail will fold. Start simple (no velocities and forces) and work your way up.
```

38 Xmlsound

```
Users Guide to FlightGear sound configuration
Version 0.9.8, October 30, 2005
Author: Erik Hofman <erik at ehofman dot com>

This document is an attempt to describe the configuration of
FlightGear flight simulator's aircraft sound in XML.

Sound Architecture:
-------------------
All of the sound configuration files are XML-encoded* property lists.
The root element of each file is always named <PropertyList>. Tags are
almost always found in pairs, with the closing tag having a slash
prefixing the tag name, i.e </PropertyList>. The exception is the tag
representing an aliased property. In this case a slash is prepended to
the closing angle bracket.  (see section Aliasing)

The top level sound configuration file is composed of a <fx>, a
<name>, a <path> sound file and zero or more <volume> and/or <pitch>
definitions.

[ Paths are relative to $FG_ROOT (the root of the installed base package .) ]
[ Absolute paths may be used. Comments are bracketed with <!-- -->.         ]

A limited sound configuration file would look something like this:

<PropertyList>
 <fx>
  <engine>
   <name>engine</name>
   <path>Sounds/wasp.wav</path>
   <mode>looped</mode>
   <condition>
    <property>/engines/engine/running</property>
   </condition>
   <volume>
    <property>/engines/engine/mp-osi</property>
    <factor>0.005</factor>
    <min>0.15</min>
```

```
    <max>0.5</max>
    <offset>0.15</offset>
   </volume>
   <pitch>
    <property>/engines/engine/rpm</property>
    <factor>0.0012</factor>
    <min>0.3</min>
    <max>5.0</max>
    <offset>0.3</offset>
   </pitch>
  </engine>
 </fx>
</PropertyList>
```

This would define an engine sound event handler for a piston engine driven aeroplane. The sound representing the engine is located in $FG_ROOT/Sounds and is named wasp.wav. The event is started when the property /engines/engine/running becomes non zero.

When that happens, the sound will be played looped (see <mode>) until the property returns zero again. As you can see the volume is mp-osi dependent, and the pitch of the sound depends on the engine rpm.

Configuration description:

<fx>
        Named FX subtree living under /sim/sound

 < ... >
        This is the event separator. The text inside the brackets
        can be anything. Bit it is advised to give it a meaningful name
        like: crank, engine, rumble, gear, squeal, flap, wind or stall

        The value can be defined multiple times, thus anything which is
        related may have the same name (grouping them together).

   <name>
        This defines the name of the event. This name is used internally
        and, although it can me defined multiple times in the same file,

```
     should normally have an unique value.

     Multiple definitions of the same name will allow multiple sections
     to interfere in the starting and stopping of the sample.

     This method can't be used to control the pitch or volume of the
     sample, but instead multiple volume or pitch section should be
     included inside the same event.

     The types "raise" and "fall" will stop the playback of the sample
     regardless of any other event. This means that when the type "raise"
     is supplied, sample playback will stop when the event turns false.
     Using the type "fall" will stop playback when the event turns true.

     IMPORTANT:
     If the trigger is used for anything else but stopping the sound
      at a certain event, all sections with the same name *should* have
     exactly the same sections for everything but property and type.

     In the case of just stopping the sample at a certain event, the
     sections for path, volume and pitch may be omitted.

<path>
     This defined th path to the sound file. The path is relative to the
     FlightGear root directory but could be specified absolute.

<condition>
     Define a condition that triggers the event.
     For a complete description of the FlightGear conditions,
     please read docs-mini/README.conditions

     An event should define either a condition or a property.

<property>
     Define which property triggers the event, and refers to a node
     in the FlightGear property tree. Action is taken when the property
     is non zero.

     A more sophisticated mechanism to trigger the event is described
     in <condition>
```

<mode>
This defines how the sample should be played:

once: the sample is played once.
this is the default.

looped: the sample plays continuously,
until the event turns false.

in-transit: the sample plays continuously,
while the property is changing its value.

<type>
This defines the type os this sample:

fx: this is the default type and doesn't need to be defined.

avionics: sounds set to this time don't have a position and
orientation but are treated as if it's mounted to
the aircraft panel. it's up to the user to define
if it can always be heard or only when in cockpit
view.

<volume> / <pitch>
Volume or Pitch definition. Currently there may be up to 5
volume and up to 5 pitch definitions defined within one sound
event. Normally all offset values are added together and the
results after property calculations will be multiplied.
A special condition occurs when the value of factor is negative,
in which case the offset doesn't get added to the other offset values
but instead will be used in the multiplication section.

<property>
Defines which property supplies the value for the calculation.
Either a <property> or an <internal> should be defined.
The value is treated as a floating point number.

<internal>
Defines which internal variable should be used for the calculation.

The value is treated as a floating point number.
The following internals are available at this time:

dt_play: the number of seconds since the sound started playing.

dt_stop: the number of seconds after the sound has stopped.

<delay-sec>
Delay after which the sound starts playing. This is useful to let a property start two sounds at the same time, where the second is delayed until the first stopped playing.

<type>
Defines the function that should be used upon the property before it is used for calculating the net result:

lin: linear handling of the property value. this is the default.

ln: convert the property value to a natural logarithmic value before scaling it. Anything below 1 will return zero.

log: convert the property value to a true logarithmic value before scaling it. Anything below 1 will return zero.

inv: inverse linear handling (1/x).

abs: absolute handling of the value (always positive).

sqrt: calculate the square root of the absolute value before scaling it.

<factor>
Defines the multiplication factor for the property value.
A special condition is when scale is defined as a negative value. In this case the result of |<scale>| * <property) will be subtracted from <default>

```
  <offset>
     The initial value for this sound. This value is also used as an
     offset value for calculating the end result.

  <min>
     Minimum allowed value.
     This is useful if sounds start to sound funny. Anything lower
     will be truncated to this value.

  <max>
     Maximum allowed value.
     This is useful if sounds gets to loud. Anything higher will be
     truncated to this value.

<position>
     Specify the position of the sounds source relative to the
     aircraft center.  The coordinate system used is a left hand
     coordinate system where +Y = left, -Y = right, -Z = down, +Z =
     up, -X = forward, +X = aft.  Distances are in meters.
     The volume calculation due to distance and orientation of the
     sounds source ONLY work on mono samples!

  <x>
     X dimension offset

  <y>
     Y dimension offset

  <z>
     Z dimension offset


<orientation>
     Specify the orientation of the sounds source.

     The zero vector is default, indicating that a Source is not directional.
     Specifying a non-zero vector will make the Source directional in
     the X,Y,Z direction

  <x>
```

```
        X dimension

      <y>
        Y dimension

      <z>
        Z dimension

      <inner-angle>
        The inner edge of the audio cone in degrees (0.0 - 180.0).
        Any sound withing that angle will be played at the current gain.

      <outer-angle>
        The outer edge of the audio cone in degrees (0.0 - 180.0).
        Any sound beyond the outer cone will be played at "outer-gain" volume.

      <outer-gain>
        The gain at the outer edge of the cone.


    <reference-dist>
        Set a reference distance of sound in meters. This is the
        distance where the volume is at its maximum.
        Volume is clamped to this maximum for any distance below.
        Volume is attenuated for any distance above.
        Attenuation depends on reference and maximum distance. See
        OpenAL specification on "AL_INVERSE_DISTANCE_CLAMPED" mode
        for details on exact computation.

    <max-dist>
        Set the maximum audible distance for the sound in meters.
        Sound is cut-off above this distance.


Creating a configuration file:
------------------------------

To make things easy, there is a default value for most entries to allow a
sane configuration when a certain entry is omitted.
```

```
Default values are:

type:   lin
factor: 1.0
offset: 0.0 for volume, 1.0 for pitch
min:    0.0
max:    0.0 (don't check)



Calculations are made the following way (for both pitch and volume):

   value = 0;
   offs = 0;

   for (n = 0;  n < max; n++) {
      if (factor < 0)
      {
         value += offset[n] - abs(factor[n]) * function(property[n]);
      }
      else
      {
          value += factor[n] * function(property[n]);
          offs += offset[n];
      }
   }

   volume = offs + value;

where function can be one of: lin, ln, log, inv, abs or sqrt
```

39 Xmlsyntax

```
XML IN FIFTEEN MINUTES OR LESS

Written by David Megginson, david@megginson.com
Last modified: $Date$

This document is in the Public Domain and comes with NO WARRANTY!
```

1. Introduction

FlightGear uses XML for much of its configuration. This document provides a minimal introduction to XML syntax, concentrating only on the parts necessary for writing and understanding FlightGear configuration files. For a full description, read the XML Recommendation at

  http://www.w3.org/TR/

This document describes general XML syntax. Most of the XML configuration files in FlightGear use a special format called "Property Lists" -- a separate document will describe the specific features of the property-list format.

2. Elements and Attributes

An XML document is a tree structure with a single root, much like a file system or a recursive, nested list structure (for LISP fans). Every node in the tree is called an _element_: the start and end of every element is marked by a _tag_: the _start tag_ appears at the beginning of the element, and the _end tag_ appears at the end.

Here is an example of a start tag:

  <foo>

Here is an example of an end tag:

  </foo>

Here is an example of an element:

  <foo>Hello, world!</foo>

The element in this example contains only data element, so it is a leaf node in the tree. Elements may also contain other elements, as in this example:

```
<bar>
 <foo>Hello, world!</foo>
 <foo>Goodbye, world!</foo>
</bar>
```

This time, the 'bar' element is a branch that contains other, nested elements, while the 'foo' elements are leaf elements that contain only data. Here's the tree in ASCII art (make sure you're not using a proportional font):

```
bar +-- foo -- "Hello, world!"
    |
    +-- foo -- "Goodbye, world!"
```

There is always one single element at the top level: it is called the _root element_. Elements may never overlap, so something like this is always wrong (try to draw it as a tree diagram, and you'll understand why):

```
<a><b></a></b>
```

Every element may have variables, called _attributes_, attached to it. The attribute consists of a simple name=value pair in the start tag:

```
<foo type="greeting">Hello, world!</foo>
```

Attribute values must be quoted with '"' or "'" (unlike in HTML), and no two attributes may have the same name.

There are rules governing what can be used as an element or attribute name. The first character of a name must be an alphabetic character or '_'; subsequent characters may be '_', '-', '.', an alphabetic character, or a numeric character. Note especially that names may not begin with a number.

3. Data

Some characters in XML documents have special meanings, and must
always be escaped when used literally:

  < <
  & &

Other characters have special meanings only in certain contexts, but
it still doesn't hurt to escape them:

  > >
  ' '
  " "

Here is how you would escape "x < 3 && y > 6" in XML data:

  x < 3 && y > 6

Most control characters are forbidden in XML documents: only tab,
newline, and carriage return are allowed (that means no ^L, for
example). Any other character can be included in an XML document as a
character reference, by using its Unicode value; for example, the
following represents the French word "cafe" with an accent on the
final 'e':

  café

By default, 8-bit XML documents use UTF-8, **NOT** ISO 8859-1 (Latin
1), so it's safest always to use character references for characters
above position 127 (i.e. for non-ASCII).

Whitespace always counts in XML documents, though some specific
applications (like property lists) have rules for ignoring it in some
contexts.

4. Comments

You can add a comment anywhere in an XML document except inside a tag or declaration using the following syntax:

```
<!-- comment -->
```

The comment text must not contain "--", so be careful about using dashes.

5. XML Declaration

Every XML document may begin with an XML declaration, starting with "<?xml" and ending with "?>". Here is an example:

```
<?xml version="1.0" encoding="UTF-8"?>
```

The XML declaration must always give the XML version, and it may also specify the encoding (and other information, not discussed here). UTF-8 is the default encoding for 8-bit documents; you could also try

```
<?xml version="1.0" encoding="ISO-8859-1"?>
```

to get ISO Latin 1, but some XML parsers might not support that (FlightGear's does, for what it's worth).

6. Other Stuff

There are other kinds of things allowed in XML documents. You don't need to use them for FlightGear, but in case anyone leaves one lying around, it would be useful to be able to recognize it.

XML documents may contain different kinds of declarations starting with "<!" and ending with ">":

```
<!DOCTYPE html SYSTEM "html.dtd">
```

```
  <!ELEMENT foo (#PCDATA)>

  <!ENTITY myname "John Smith">
```

and so on. They may also contain processing instructions, which look a bit like the XML declaration:

```
  <?foo processing instruction?>
```

Finally, they may contain references to _entities_, like the ones used for escaping special characters, but with different names (we're trying to avoid these in FlightGear):

```
  &chapter1;

  &myname;
```

Enjoy.

40 Yasim

Coordinate system notes: All positions specified are in meters (which is weird, since all other units in the file are English). The X axis points forward, Y is left, and Z is up. Take your right hand, and hold it like a gun. Your first and second fingers are the X and Y axes, and your upwards-pointing thumb is the Z. This is slightly different from the coordinate system used by JSBSim. Sorry. The origin can be placed anywhere, so long as you are consistent. I use the nose of the aircraft.

XML Elements
---

airplane: The top-level element for the file. It contains only one
attribute:
mass: The empty (no fuel) weight, in pounds.

```
approach: The approach parameters for the aircraft.  The solver will
          generate an aircraft that matches these settings.  The element
          can (and should) contain <control> elements indicating pilot
          input settings, such as flaps and throttle, for the
          approach.
          speed: The approach airspeed, in knots TAS.
          aoa:   The approach angle of attack, in degrees
          fuel:  Fraction (0-1) of fuel in the tanks.  Default is 0.2.

cruise:   The cruise speed and altitude for the solver to match.  As
          above, this should contain <control> elements indicating
          aircraft configuration.  Especially, make sure the engines
          are generating enough thrust at cruise!
          speed: The cruise speed, in knots TAS.
          alt:   The cruise altitude, in feet MSL.
          fuel:  Fraction (0-1) of fuel in the tanks.  Default is 0.2.

cockpit:  The location of the cockpit (pilot eyepoint).
          x,y,z: eyepoint location (see coordinates note)

fuselage: This defines a tubelike structure.  It will be given an even
          mass and aerodynamic force distribution by the solver.  You
          can have as many as you like, in any orientation you please.
          ax,ay,az: One end of the tube (typically the front)
          bx,by,bz: The other ("back") end.
          width:    The width of the tube, in meters.
          taper:    The approximate radius at the "tips" of the fuselage
                    expressed as a fraction (0-1) of the width value.
          midpoint: The location of the widest part of the fuselage,
                    expressed as a fraction of the distance between A and B.
          idrag:    Multiplier for the "induced drag" generated by this
                    object. Default is one. With idrag=0 the fuselage
                    generates only drag.
          cx,cy,cz: Factors for the generated drag in the fuselages "local
                    coordinate system" with x pointing from end to front,
                    z perpendicular to x with y=0 in the aircraft coordinate
                    system. E.g. for a fuselage of a height of 2 times the
                    width you can define cy=2 and (due to the doubled front
                    surface) cx=2.
```

wing: This defines the main wing of the aircraft. You can have only one (but see below about using vstab objects for extra lifting surfaces). The wing should have a <stall> subelement to indicate stall behavior, control surface subelements (flap0, flap1, spoiler, slat) to indicate what and where the control surfaces are, and <control> subelements to map user input properties to the control surfaces.

- x,y,z: The "base" of the wing, specified as the location of the mid-chord (not leading edge, trailing edge, or aerodynamic center) point at the root of the LEFT (!) wing.
- length: The length from the base of the wing to the midchord point at the tip. Note that this is not the same thing as span.
- chord: The chord of the wing at its base, along the X axis (not normal to the leading edge, as it is sometimes defined).
- incidence: The incidence angle at the wing root, in degrees. Zero is level with the fuselage (as in an aerobatic plane), positive means that the leading edge is higher than the trailing edge (as in a trainer).
- twist: The difference between the incidence angle at the wing root and the incidence angle at the wing tip. Typically, this is a negative number so that the wing tips have a lower angle of attack and stall after the wing root (washout).
- taper: The taper fraction, expressed as the tip chord divided by the root chord. A taper of one is a hershey bar wing, and zero would be a wing ending at a point. Defaults to one.
- sweep: The sweep angle of the wing, in degrees. Zero is no sweep, positive angles are swept back. Defaults to zero.
- dihedral: The dihedral angle of the wing. Positive angles are upward dihedral. Defaults to zero.
- idrag: Multiplier for the "induced drag" generated by this surface. In general, low aspect wings will generate less induced drag per-AoA than high aspect (glider) wings. This value isn't

constrained well by the solution process, and may require tuning to get throttle settings correct in high AoA (approach) situations.

camber: The lift produced by the wing at zero angle of attack, expressed as a fraction of the maximum lift produced at the stall AoA.

hstab: These defines the horizontal stabilizer of the aircraft. Internally, it is just a wing object and therefore works the same in XML. You are allowed only one hstab object; the solver needs to know which wing's incidence to play with to get the aircraft trimmed correctly.

vstab: A "vertical" stabilizer. Like hstab, this is just another wing, with a few special properties. The surface is not "mirrored" as are wing and hstab objects. If you define a left wing only, you'll only get a left wing. The default dihedral, if unspecified, is 90 degrees instead of zero. But all parameters are equally settable, so there's no requirement that this object be "vertical" at all. You can use it for anything you like, such as extra wings for biplanes. Most importantly, these surfaces are not involved with the solver computation, so you can have none, or as many as you like.

mstab: A mirrored horizontal stabilizer. Exactly the same as wing, but not involved with the solver computation, so you can have none, or as many as you like.

stall: A subelement of a wing (or hstab/vstab/mstab) that specifies the stall behavior.

aoa: The stall angle (maximum lift) in degrees. Note that this is relative to the wing, not the fuselage (since the wing may have a non-zero incidence angle).

width: The "width" of the stall, in degrees. A high value indicates a gentle stall. Low values are viscious for a non-twisted wing, but are acceptable for a twisted one (since the whole wing will not stall at the same time).

peak: The height of the lift peak, relative to the

post-stall secondary lift peak at 45 degrees. Defaults to 1.5. This one is deep voodoo, and probably doesn't need to change much. Bug me for an explanation if you're curious.

flap0, flap1, slat, spoiler:
These are subelements of wing/hstab/vstab objects, and specify the location and effectiveness of the control surfaces.
start: The position along the wing where the control surface begins. Zero is the root, one is the tip.
end: The position where the surface ends, as above.
lift: The lift multiplier for a flap or slat at full extension. One is a no-op, a typical aileron might be 1.2 or so, a giant jetliner flap 2.0, and a spoiler 0.0. For spoilers, the interpretation is a little different -- they spoil only "prestall" lift. Lift due purely to "flat plate" effects isn't affected. For typical wings that stall at low AoA's essentially all lift is pre-stall and you don't have to care. Jet fighters tend not to have wing spoilers, for exactly this reason. This value is not applicable to slats, which affect stall AoA only.
drag: The drag multiplier, as above. Typically should be higher than the lift multiplier for flaps.
aoa: Applicable only to slats. This indicates the angle by which the stall AoA is translated by the slat extension.

thruster: A very simple "thrust only" engine object. Useful for things like thrust vectoring nozzles. All it does is map its THROTTLE input axis to its output thrust rating. Does not consume fuel, etc...
thrust: Maximum thrust in pounds
x,y,z: The point on the airframe where thrust will be applied.
vx,vy,vy: The direction of the thrust in airframe coordinates. The vector will be normalized automatically, so any non-zero vector will work fine.

```
jet:      A turbojet/fan engine.  It accepts a <control> subelement to map a
          property to its throttle setting, and an <actionpt> subelement
          to place the action point of the thrust at a different
          position than the mass of the engine.
          x,y,z:          The location of the engine, as a point mass.
                          If no actionpt is specified, this will also
                          be the point of application of thrust.
          mass:           The mass of the engine, in pounds.
          thrust:         The maximum sea-level thrust, in pounds.
          afterburner:    Maximum total thrust with afterburner/reheat,
                          in pounds [defaults to "no additional
                          thrust"].
          rotate:         Vector angle of the thrust in degrees about the
                          Y axis [0].
          n1-idle:        Idling rotor speed [55].
          n1-max:         Maximum rotor speed [102].
          n2-idle:        Idling compressor speed [73].
          n2-max:         Maximum compressor speed [103].
          tsfc:           Thrust-specific fuel consumption [0.8].
                          This should be considerably lower for modern
                          turbofans.
          egt:            Exhaust gas temperature at takeoff [1050].
          epr:            Engine pressure ratio at takeoff [3.0].
          exhaust-speed:  The maximum exhaust speed in knots [~1555].
          spool-time:     Time, in seconds, for the engine to respond to
                          90% of a commanded power setting.

propeller: A propeller.  This element requires an engine subtag.
           Currently <piston-engine> and <turbine-engine> are
           supported.
           x,y,z:         The position of the mass (!) of the
                          engine/propeller combination.  If the point
                          of force application is different (and it
                          will be) it should be set with an <actionpt>
                          subelement.
           mass:          The mass of the engine/propeller, in pounds.
           moment:        The moment, in kg-meters^2.  This has to be
                          hand calculated and guessed at for now.  A
                          more automated system will be forthcoming.
```

```
                Use a negative moment value for
                counter-rotating ("European" -- CCW as seen
                from behind the prop) propellers.
                A good guess for this value is the radius of
                the prop (in meters) squared times the mass
                (kg) divided by three; that is the moment of
                a plain "stick" bolted to the prop shaft.
radius:         The radius, in meters, or the propeller.
cruise-speed:   The max efficiency cruise speed of the
                propeller.  Generally not the same as the
                aircraft's cruise speed.
cruise-rpm:     The RPM of the propeller at max-eff. cruise.
cruise-power:   The power sunk by the prop at cruise, in horsepower.
cruise-alt:     The reference cruise altitude in feet.
takeoff-power:  The takeoff power required by the propeller...
takeoff-rpm:    ...at the given takeoff RPM.
min-rpm:        The minimum operational RPM for a constant speed
                propeller.  This is the speed to which the
                prop governor will seek when the blue lever
                is at minimum.  The coarse-stop attribute
                limits how far the governor can go into trying
                to reach this RPM.
max-rpm:        The maximum operational RPM for a constant speed
                propeller.  See above.  The fine-stop attribute
                limits how far the governor can go in trying
                to reach this RPM.
fine-stop:      The minimum pitch of the propeller (high RPM) as a
                ratio of ideal cruise pitch.  This is set to 0.25
                by default -- a higher value will result in a
                lower RPM at low power settings (e.g. idle, taxi,
                and approach).
coarse-stop:    The maximum pitch of the propeller (low RPM) as
                a ratio of ideal cruise pitch.  This is set to
                4.0 by default -- a lower value may result in a
                higher RPM at high power settings.
gear-ratio:     The factor by which the engine RPM is multiplied
                to produce the propeller RPM.  Optional (defaults
                to 1.0).
contra:         When set (contra="1"), this indicates that the
                propeller is a contra-rotating pair.  It
```

```
                        will not contribute to the aircraft's net
                        gyroscopic moment, nor will it produce
                        asymmetric torque on the aircraft body.
                        Asymmetric slipstream effects, when
                        implemented, will also be zero when this is
                        set.

    piston-engine: A piston engine definition.  This must be a subelement
                   of an enclosing <propeller> tag.
                   eng-power:    Maximum BHP of the engine at sea level.
                   eng-rpm:      The engine RPM at which eng-power is developed
                   displacement: The engine displacement in cubic inches.
                   compression:  The engine compression ratio.
                   turbo-mul:    The turbo/super-charger pressure multiplier.
                                 Static pressure will be multiplied by this
                                 value to get the manifold pressure.
                   wastegate-mp: The maximum manifold pressure.  Beyond
                                 this, the gate will release to keep the
                                 MP below this number. (inHG).  This value
                                 can be changed at runtime using the
                                 WASTEGATE control axis, which is a
                                 multiplier in the range [0:1].
                   turbo-lag:    Time lag, in seconds, for 90% of a power change
                                 to be reflected in the turbocharger boost
                                 pressure.

    turbine-engine: A turbine engine definition.  This must be a subelement
                    of an enclosing <propeller> tag.
                    eng-power:   Maximum BHP of the engine at a suitable
                                 cruise altitude.
                    eng-rpm:     The engine RPM at which eng-power is
                                 developed.  Note that this is "shaft" RPM
                                 as seen by the propeller.  Don't use a
                                 gear-ratio on the enclosing propeller, or
                                 else you'll get confused. :)
                    alt:         The altitude at which eng-power is developed.
                                 This should be high enough to be lower (!)
                                 than the flat-rating power.
                    flat-rating: The maximum allowed power developed by
                                 the engine.  Most turboprops are flat
```

rated below a certain altitude and temperature range to prevent engine damage.

min-n2: N2 (percent) turbine speed at zero throttle.

max-n2: N2 (percent) turbine speed at max throttle.

bsfc: Specific fuel consumption, in lbs/hr per horsepower.

actionpt: Defines an "action point" for an enclosing jet or propeller element. This is the location where the force from the thruster will be applied.

x,y,z: The location of force application.

gear: Defines a landing gear. Accepts <control> subelements to map properties to steering and braking. Can also be used to simulate floats. Although the coefficients are still called ..fric, it is calculated in fluids as a drag (proportional to the square of the speed). In fluids gears are not considered to detect crashes (as on ground).

x,y,z: The location of the fully-extended gear tip.

compression: The distance in meters along the "up" axis that the gear will compress.

initial-load: The initial load of the spring in multiples of compression. Defaults to 0. (With this parameter a lower spring-constants will be used for the gear-> can reduce numerical problems (jitter)) Note: the spring-constant is varied from 0% compression to 20% compression to get continuous behavior around 0 compression. (could be physically explained by wheel deformation)

upx/upy/upz: The direction of compression, defaults to vertical (0,0,1) if unspecified. These are used only for a direction -- the vector need not be normalized, as the length is specified by "compression".

sfric: Static (non-skidding) coefficient of friction. Defaults to 0.8.

dfric: Dynamic friction. Defaults to 0.7.

spring: A dimensionless multiplier for the automatically

```
                generated spring constant.  Increase to make
                the gear stiffer, decrease to make it
                squishier.
        damp:   A dimensionless multiplier for the automatically
                generated damping coefficient.  Decrease to
                make the gear "bouncier", increase to make it
                "slower".  Beware of increasing this too far:
                very high damping forces can make the numerics
                unstable.  If you can't make the gear stop
                bouncing with this number, try increasing the
                compression length instead.
        on-water:   if this is set to "0" the gear will be ignored if
                on water. Defaults to "0"
        on-solid:   if this set to "0" the gear will be ignored if
                not on water. Defaults to "1"
        speed-planing:
        spring-factor-not-planing:
                At zero speed the spring factor is multiplied by
                spring-factor-not-planing. Above speed-planing this
                factor is equal to 1. The idea is, to use this for
                floats simulating the transition from swimming to
                planing. speed-planing defaults to 0,
                spring-factor-not-planing defaults to 1.
        reduce-friction-by-extension: at full extension the friction is
                reduced by this relative value. 0.7 means 30% friction
                at full extension. If you specify a value greater
                than one, the friction will be zero before reaching
                full extension. Defaults to "0"
        ignored-by-solver: with the on-water/on-solid tags you can have more
                than one set of gears in one aircraft, If the solver
                (who automatically generates the spring constants)
                would take all gears into account, the result would be
                wrong. E. G. set this tag to "1" for all gears, which
                are not active on runways. Defaults to "0". You can
                not exclude all gears in the solving process.

launchbar: Defines a catapult launchbar or strop. The default acceleration
           provided by the catapult is 25m/s^2. This can be
           modified by the use of the control axis LACCEL.
         x,y,z:     The location of the mount point of the launch bar or
```

strop on the aircraft.
length: The length of the launch bar from mount point to tip
down-angle: The max angle below the horizontal the launchbar can achieve.
up-angle: The max angle above the horizontal the launchbar can achieve.
holdback-{x,y,z}: The location of the holdback mount point on the aircraft.
holdback-length: The length of the holdback from mount point to tip. Note: holdback up-angle and down-angle are the same as those defined for the launchbar and are not specified in the configuration.

tank: A fuel tank. Tanks in the aircraft are identified numerically (starting from zero), in the order they are defined in the file. If the left tank is first, "tank[0]" will be the left tank.
x,y,z: The location of the tank.
capacity: The maximum contents of the tank, in pounds. Not gallons -- YASim supports fuels of varying densities.
jet: A boolean. If present, this causes the fuel density to be treated as Jet-A. Otherwise, gasoline density is used. A more elaborate density setting (in pounds per gallon, for example) would be easy to implement. Bug me.

ballast: This is a mechanism for modifying the mass distribution of the aircraft. A ballast setting specifies that a particular amount of the empty weight of the aircraft must be placed at a given location. The remaining non-ballast weight will be distributed "intelligently" across the fuselage and wing objects. Note again: this does NOT change the empty weight of the aircraft.
x,y,z: The location of the ballast.
mass: How much mass, in pounds, to put there. Note that this value can be negative. I find that I often need to "lighten" the tail of the aircraft.

```
weight:   This is an added weight, something not part of the empty
          weight of the aircraft, like passengers, cargo, or external
          stores.  The actual value of the mass is not specified here,
          instead, a mapping to a property is used.  This allows
          external code, such as the panel, to control the weight
          (loading a given cargo configuration from preference files,
          dropping bombs at runtime, etc...)
          x,y,z:      The location of the weight.
          mass-prop:  The name of the fgfs property containing the
                      mass, in pounds, of this weight.
          size:       The aerodynamic "size", in meters, of the
                      object.  This is important for external stores,
                      which will cause drag.  For reasonably
                      aerodynamic stuff like bombs, the size should be
                      roughly the width of the object.  For other
                      stuff, you're on your own.  The default is zero,
                      which results in no aerodynamic force (internal
                      cargo).

solve-weight:
          Subtag of approach and cruise parameters.  Used to specify a
          non-zero setting for a <weight> tag during solution.  The
          default is to assume all weights are zero at the given
          performance numbers.
          idx:    Index of the weight in the file (starting with zero).
          weight: Weight setting in pounds.


control-input:
          This element manages a mapping from fgfs properties (user
          input) to settable values on the aircraft's objects.  Note
          that the value to be set MUST (!) be valid on the given
          object type.  This is not checked for by the parser, and
          will cause a runtime crash if you try it.  Wing's don't have
          throttle controls, etc...  Note that multiple axes may be
          set on the same value.  They are summed before setting.

          axis:  The name of the double-valued fgfs property "axis" to
                 use as input, such as "/controls/flight/aileron".
          control: Which control axis to set on the objects.  It can have
```

```
                 the following values:
                THROTTLE - The throttle on a jet or propeller.
                MIXTURE - The mixture on a propeller.
                REHEAT - The afterburner on a jet
                PROP - The propeller advance
                BRAKE - The brake on a gear.
                STEER - The steering angle on a gear.
                INCIDENCE - The incidence angle of a wing.
                FLAP0 - The flap0 deflection of a wing.
                FLAP1 - The flap1 deflection of a wing.
                FLAP[0/1]EFFECTIVENESS - a multiplier for flap lift, but not drag
                                         (useful for blown flaps)
                SLAT - The slat extension of a wing.
                SPOILER - The spoiler extension for a wing.
                CYCLICAIL - The "aileron" cyclic input of a rotor
                CYCLICELE - The "elevator" cyclic input of a rotor
                COLLECTIVE - The collective input of a rotor
                ROTORENGINEON - If not equal zero the rotor is rotating
                WINCHRELSPEED - The relative winch speed
        LACCEL - The acceleration provided by the catapult.
                {... and many more, see FGFDM.cpp ...}
        invert: Negate the value of the property before setting on
                the object.
        split:  Applicable to wing control surfaces.  Sets the
                normal value on the left wing, and a negated value
                on the right wing.
        square: Squares the value before setting.  Useful for
                controls like steering that need a wide range, yet
                lots of sensitivity in the center.  Obviously only
                applicable to values that have a range of [-1:1] or
                [0:1].
        src0/src1/dst0/dst1:
                If present, these defined a linear mapping from the
                source to the output value.  Input values in the
                range src0-src1 are mapped linearly to dst0-dst1,
                with clamping for input values that lie outside the
                range.

control-output:
        This can be used to pass the value of a YASim control axis
```

(after all mapping and summing is applied) back to the property tree.

control: Name of the control axis. See above.
prop: Property node to receive the value.
side: Optional, for split controls. Either "right" or "left"
min/max: Clamping applied to output value.

control-speed:
Some controls (most notably flaps and hydraulics) have maximum slew rates and cannot respond instantly to pilot input. This can be implemented with a control-speed tag, which defines a "transition time" required to slew through the full input range. Note that this tag is semi-deprecated, complicated control input filtering can be done much more robustly from a Nasal script.

control: Name of the control axis. See above.
transition-time: Time in seconds to slew through input range.

control-setting:
This tag is used to define a particular setting for a control axis inside the <cruise> or <approach> tags, where obviously property input is not available. It can be used, for example, to inform the solver that the approach performance values assume full flaps, etc...

axis: Name of the control input (i.e. a property name)
value: Value of the control axis.

hitch: A hitch, can be used for winch-start (in gliders) or aerotow (in gliders and motor aircrafts) or for external cargo with helicopter. You can do aerotow over the net via multiplayer (see j3 and bocian as an example).

name: the name of the hitch. must be aerotow if you want to do aerotow via multiplayer. You will find many properties at /sim/hitches/name. Most of them are directly tied to the internal variables, you can modify them as you like. You can add a listener to the property "broken", e. g. for

```
                playing a sound.
            x,y,z: The position of the hitch
            force-is-calculated-by-other: if you want to simulate aerotowing
                over the internet, set this value to "1" in the motor
                aircraft. Don't specify or set this to zero in gliders.
                In a LAN the time lag might be small enough to set it on
                both aircrafts to "0". It's intended, that this is done
                automatically in the future.

tow: The tow used for aerotow or winch. This must be a subelement
                of an enclosing <hitch> tag.
            length: upstretched length in m
            weight-per-meter: in kg/m
            elastic-constant: lower values give higher elasticity
            break-force: in N
            mp-auto-connect-period: the every x seconds a towed multiplayer
                aircraft is searched. If found, this tow is connected
                automatically, parameters are copied from the other
                aircraft. Should be set only in the motor aircraft, not
                in the glider

winch: The tow used for aerotow or winch. This must be a subelement
                of an enclosing <hitch> tag.
            max-tow-length:
            min-tow-length:
            initial-tow-length: all are in m. The initial tow length also
                defines the length/search radius used for the mp-autoconnect
                feature
            max-winch-speed: in m/s
            power: in kW
            max-force: in N


rotor:      A rotor. Used for simulating helicopters. You can have one, two
            or even more.
            There is a drawing of a rotor in the Doc-directory
            (README.yasim.rotor.png) Please find the measures from this drawing
            for several parameters in square brackets [].
            If you specify a rotor, you do not need to specify a wing or hstab,
            the settings for approach and cruise will be ignored then. You have
```

to specify the solver results manually. See below.
The rotor generates downwash acting on all stabs, surfaces and fuselages. For all fuselages in the rotor downwash you should specify idrag="0" to get realistic results.

name: The name of the rotor.
(some data is stored at /rotors/name/)
The rpm, cone angle, yaw angle and roll angle are stored for the complete rotor. For every blade the position angle, the flap angle and the incidence angle are stored. All angles are in degree, positive values always mean "up". This is not completely tested, but seem to work at least for rotors rotating counterclockwise.
A value stall gives the fraction of the rotor in stall (weighted by the fraction the have on lift and drag without stall). Use this for modifying the rotor-sound.

x,y,z: The position of the rotor center

nx,ny,nz: The normal of the rotor (pointing upwards, will be normalized by the computer)

fx,fy,fz: A Vector pointing forward, if not perpendicular to the normal it will be corrected by the computer

diameter: The diameter in meter [D]

numblades: The number of blades

weightperblade: The weight per blade in pounds

relbladecenter: The relative center of gravity of the blade. Maybe not 100% correct interpreted; use 0.5 for the start and change in small steps [b/R]

chord: The chord of the blade its base, along the X axis (not normal to the leading edge, as it is sometimes defined). [c]

twist: The difference between the incidence angle at the blade root and the incidence angle at the wing tip. Typically, this is a negative number so that the rotor tips have a lower angle of attack.

taper: The taper fraction, expressed as the tip chord divided by the root chord. A taper of one is a bar blade, and zero would be a blade ending at a point. Defaults to one. [d/c]

rel-len-where-incidence-is-measured: If the blade is twisted, you need a point where to measure the incidence angle.

```
          Zero means at the base, 1 means at the tip. Typically
          it should be something near 0.7
rel-len-blade-start: Typically the blade is not mounted in the
        center of the rotor [a/R]
rpm:    rounds per minute.
phi0:   initial position of this rotor
ccw:    determines if the rotor rotates clockwise (="0") or
        counterclockwise (="1"), (if you look on the top of the
        normal, so the bo105 has counterclockwise rotor).
        "true" and "false" are not any longer supported to
        increase my lifespan. ;-)
maxcollective: The maximum of the collective incidence in degree
mincollective: The minimum of the collective incidence in degree
maxcyclicele: The maximum of the cyclic incidence in degree for
        the elevator like function
mincyclicele: The minimum of the cyclic incidence in degree for
        the elevator like function
maxcyclicail: The maximum of the cyclic incidence in degree for
        the aileron like function
mincyclicail: The minimum of the cyclic incidence in degree for
        the aileron like function
airfoil-incidence-no-lift: non symmetric airfoils produces lift
        with no incidence. This is is the incidence, where the
        airfoil is producing no lift. Zero for symmetrical airfoils
        (default)
incidence-stall-zero-speed:
incidence-stall-half-sonic-speed: the stall incidence is a function
        of the speed. I found some measured data, where this is
        linear over a wide range of speed. Of course the linear
        region ends at higher speeds than zero, but just
        extrapolate the linear behavior to zero.
lift-factor-stall: In stall airfoils produce less lift. Without
        stall the c-lift of the profile is assumed to be
        sin(incidence-"airfoil-incidence-no-lift")*liftcoef;
        And in stall:
        sin(2*(incidence-"airfoil-incidence-no-lift"))*liftcoef*...
        ..."lift-factor-stall";
        Therefore this factor is not the quotient between lift
        with and without stall. Use 0.28 if you have no idea.
drag-factor-stall: The drag of an airfoil in stall is larger than
```

```
         without stall.
         Without stall c-drag is assumed to be
         abs(sin(incidence-"airfoil-incidence-no-lift"))...
         ..*dragcoef1+dragcoef0);
         With stall this is multiplied by drag-factor
stall-change-over: For incidence<"incidence-stall" there is no stall.
         For incidence>("incidence-stall"+"stall-change-over") there
         is stall. In the range between this incidences it is
         interpolated linear.

pitch-a:
pitch-b: collective incidence angles, If you start flightgear
         with --log-level=info, flightgear reports lift and needed
         power for theses incidence angles
forceatpitch-a:
poweratpitch-b:
poweratpitch-0: old tokens, not supported any longer, the result are
         not exactly the expected lift and power values. Will be
         removed in one of the next updates.directly.Use "real"
         coefficients instead (see below) and adjust the lift with
         rotor-correction-factor.

The airfoil of the rotor is described as follows:
The way is to define the lift and drag coefficients directly.
Without stall the c-lift of the profile is assumed to be
         sin(incidence-"airfoil-incidence-no-lift")*liftcoef;
And in stall:
         sin(2*(incidence-"airfoil-incidence-no-lift"))*liftcoef*...
         ..."lift-factor-stall";
Without stall c-drag is assumed to be
         abs(sin(incidence-"airfoil-incidence-no-lift"))...
         ..*dragcoef1+dragcoef0);
See above, how the coefficients are defined with stall.
The parameters:
airfoil-lift-coefficient: liftcoef
airfoil-drag-coefficient0: dragcoef0
airfoil-drag-coefficient1: dragcoef1
         To find the right values: see README.yasim.rotor.ods
         (Open Office file) or README.yasim.rotor.xls (Excel
         file). With theses files you can generate graphs of the
```

airfoil coefficients and adjust the parameters to match real airfoils. For many airfoils you find data published in the internet. Parameters for the airfoils NACA 23012 (main rotor of bo105) and NACA 0012 (tail rotor of bo105?) are included.

rotor-correction-factor:
If you calculate the lift of a heli rotor or even of a propeller, you get a value larger than the real measured one. (Due to vortex effects.) This is considered in the simulation, but with a old theory by Prantl, which is known to give still too large. This is corrected by this token, default: 1

flapmin: Minimum flapping angle. (Should normally never reached)

flapmax: Maximum flapping angle. (Should normally never reached)

flap0: Flapping angle at no rotation, i.e. -5

dynamic: this changes the reactions speed of the rotor to an input. normally 1 (Maybe there are rotors with a little faster reaction, than use a value a little greater than one. A value greater than one will result in a more inert, system. Maybe it's useful for simulating the rotor of the Bell UH1

rellenflaphinge: The relative length from the center of the rotor to the flapping hinge. Can be taken from pictures of the helicopter (i.e. 0 for Bell206, about 0.05 for most rotors) For rotors without flapping hinge (where the blade are twisted instead, i.e. Bo 105, Lynx) use a mean value, maybe 0.2. This value has a extreme result in the behavior of the rotor [F/r]

sharedflaphinge: determines, if the rotor has one central flapping hinge (="1") for the blades (like the Bell206 or the tail rotor of the Bo 105), default is "0".

delta3: Some rotors have a delta3 effect, which results in a decreasing of the incidence when the rotor is flapping. A value of 0 (as most helicopters have) means no change in incidence, a value of 1 result in a decreases of one degree per one degree flapping.
So delta3 is the proportional factor between flapping and decrease of incidence. I.e. the tail rotor of a Bo105 has a delta3 of 1.

In some publications delta3 is described by an angle. The value in YASim is the atan of this angle

delta: A factor for the damping constant for the flapping. 1 means a analytical result, which is only a approximation. Has a very strong result in the reaction of the rotor system on control inputs.
If you know the flapping angle for a given cyclic input you can adjust this by changing this value. Or if you now the maximum roll rate or ...

translift-maxfactor: Helicopters have "translational lift", which is due to turbulence. In forward flying the rotor gets less turbulence air and produces more lift. The factor is the quotient between lift at high airspeeds to the lift at hover (with same pitch).

translift-ve: the speed, where the translational lift reaches 1/e of the maximum value. In m/s.

ground-effect-constant: Near to the ground the rotor produces more torque than in higher altitudes. The ground effect is calculated as
factor = 1+diameter/altitude*"ground-effect-constant"

number-of-parts:

number-of-segments: The rotor is simulated in "number-of-parts" different directions.
In every direction the rotor is simulated at number-of-segments points. If the value is to small, the rotor will react unrealistic. If it is to high, cpu-power will be wasted. I now use a value of 8 for "number-of-parts" and 8 for number-of-segments for the main rotor and 4 for "number-of-parts" and 5 for "number-of-segments" for the tail rotor.
"number-of-parts" must be a multiple of 4 (if not, it is corrected)

cyclic-factor: The response of a rotor to cyclic input is hard to calculate (its a damped oscillator in resonance, some parameters have very large impact to the cyclic response)
With this parameter (default 1) you can adjust the simulator to the real helo.

downwashfactor: A factor for the downwash of the rotor, default 1.

balance: The balance of the rotor. 1.0: the rotor is 100% balanced, 0.0: half of the blades are missing. Use a value near one

```
                (0.98 ... 0.999) to add some vibration.
        tiltcenterx:
        tiltcentery:
        tiltcenterz: The center for the tilting of the complete rotorhead/
                     mast. Can be used for simulating of the Osprey or small
                     autogyros.
        mintiltyaw:
        mintiltpitch:
        mintiltroll:
        maxtiltyaw:
        maxtiltpitch:
        maxtiltroll: The limits (in degree) for tilting the rotor head

        All rotor can have <control> subelements for the cyclic
        (CYCLICELE, CYCLICAIL) and collective (COLLECTIVE) input.
        and can have <control> subelements for the tilting the whole rotor
        head around the y-axis (TILTPITCH), the x-axis (TILTROLL) and the
        z-axis (TILTYAW). ROTORBALANCE is a factor for the balance.

rotorgear: If you are using one or more rotors you have to define a
        rotorgear. It connects all the rotors and adds a simple engine.
        In future it will be possible, to add a YASim-engine.
        max-power-engine: the maximum power of the engine, in kW.
        engine-prop-factor: the engine is working as a pd-regulator. This
                is the width of the regulation-band, or, in other words,
                the inverse of the proportional-factor of the regulator.
                If you set it to 0.02, than up to 98% of the rotor-rpm
                the engine will produce maximum torque. At 100% of
                the engine will produce no torque.  It is planned to use
                YASim-engines instead of this simple engine.
        engine-accel-limit: The d-factor of the engine is defined as the
                maximum acceleration rate of the engine in %/s,
                default is 5%/s.
        max-power-rotor-brake: the maximum power of the rotor brake, in kW
                at normal rpm (most? real rotor brakes would be overheated
                if used at normal rpm, but this is not simulated now)
        rotorgear-friction: the power loss due to friction in kW at normal
                RPM
        yasimdragfactor:
        yasimliftfactor: the solver is not working with rotor-aircraft.
```

Therefore you have to specify the results yourself.
10 for drag and 140 for lift seem to be good starting
values. Although the solve is not invoked for aircraft
with at least one rotor, you need to specify the cruise
and the approach settings. The approach speed is needed to
calculate the gear springs. Use a speed of approx. 50knots.
They do not need to match any real value.

The rotorgear needs a <control> subelement for the engine
(ROTORGEARENGINEON) and can have further <control> subelements:

ROTORBRAKE: rotor brake

ROTORRELTARGET: the target rpm of the engine relative to
the "normal" value for the governor. Default is
1.

ROTORENGINEMAXRELTORQUE: the maximum torque of the engine
relative to the torque defined by the engine-
power. Default is 1. By setting the rel-target
to a large number you get control over the
engine by this control.
Alternatively you can use these two values for
individual start-up sequences (see the s58)