CHARTER

Version 1.0
May 9, 2007

A component of:

SIGNAL

Simulation and Integration of Ground, Network, and Air Links

Status:

Operational

Connections:

Charter supports connections from all SIGNAL clients. This includes Acd Arts, Acd Console, CommonArts, Dsrem, Dedem, Nasem, Pilot, Prmcs, Starstcw, Stars Fsl2, Tower2d, Tower 3d, Non-Radar Clock, and the Control interface.

Overview:

This component provides air traffic simulation-hosting capability to multiple discrete exercises. It focuses on the simulation of the real world, such as moving aircraft and accounting for the effects of wind, weather, and altitude. For each exercise, it manages a virtual airspace that can be manipulated by the clients connected to that exercise. Usually, one copy of Charter serves an entire IIDS classroom. This is the core of the SIGNAL system.

Charter is implemented using Visual C++ 6 using the MFC Document/View architecture. All communications with clients are done via streaming sockets over TCP/IP. It has a simple list based interface showing exercises and information about scenarios loaded into those scenarios. Although it may be used interactively directly from its interface, the Control client is usually used to control it remotely.

How It Works:

Charter begins by opening a listening socket to which clients may connect. When a client process connects, a unique socket connection is created for it and a read is posted on it. The client process is expected to send a standard packet format with a code indicating the type of client and a number indicating the exercise to which it wishes to connect. From that point, the specific messages exchanged between the client and Charter is dependent upon the type of client. These message formats are fully defined in the Socket Packet Descriptions for each client.

One of the clients which may connect is a Control client. This client is able to send messages to tell Charter to load and unload scenarios for exercises. It is the only client able to manipulate multiple exercises. All other clients are limited to the exercise to which they initially connected. Once a scenario is loaded, both the Control and Pilot clients may issue play, rewind, replay, and pause commands for scenarios.

All socket communications between Charter and clients is converted to simple ASCII strings by a socket interface. This is done to prevent problems with base data type size differences between different platforms as well as avoid byte order issues between big and little-endian machines.

Event Driven Processing:

Charter is event driven, using both system events and aircraft specific events. Pilot commands to the simulation are converted into events as well to facilitate replay and common control.

System Event:

System events are those events that change the environment in which aircraft operate. These events are triggered by time. The system events for Charter are defined below:

- Altimeter Station Changes – (EnRoute Only) modifies the clock and altimeter readings for a specific weather station.
- Altimeter Set – (Terminal) sets the general altimeter reading.
- System Information – (EnRoute and Terminal) sets the system information, which is a brief description of the scenario's purpose.
- Display Weather Pattern – (EnRoute and Terminal) selects a weather pattern to display for an exercise.

- Inhibit/Uninhibit Center Interface –
- Delay All Departures – (EnRoute and Terminal) delays departures from a specified airport by a specified number of minutes.
- Activate/Deactivate Runway – (EnRoute and Terminal) makes a specified runway active/inactive at a specified airport.
- Display/Remove Lost Radar Message – Simulates a loss or regain of radar data for an EnRoute host.
- Alphanumeric Failure/Recovery – Fails and recovers the display of all alphanumeric on the scope. In terminal, this simulates a loss of the ARTS.
- System Radar Failure/Recovery – Loss and recovery of primary and secondary targets on the radar display.
- Environmental Data – Sets the environmental data readout information.
- Scenario Information – Sets the scenario information.
- Change ATIS C and GI Info – (Terminal) Changes the ATIS and general information line of the systems information area.
- Ghost Pilot Prompt Message – (EnRoute and Terminal) generates a ghost prompt for the Pilot. On some exercises, a Pilot is expected to respond to the student as a controller from another facility. The scenario developer may use this message to prompt the ghost pilot to make a call as another controller to the student.
- System Prompt Message – (EnRoute and Terminal) generates a system prompt for all Pilots connected to the exercise. The scenario developer may use this message to warn the pilots about upcoming events or to change the way the pilot responds to the student issued instructions.
- Add New Aircraft – (EnRoute and Terminal) generates a new aircraft while a scenario is running. A Pilot initiates this system event. Instructors may use this capability to increase the complexity level of a problem or to create specific situations to demonstrate advanced air traffic control concepts.
- Duplicate Aircraft – (EnRoute and Terminal) generates a new aircraft while a scenario is running at the exact position, speed, and heading as the source aircraft. A Pilot initiates this system event. Instructors may use this capability to simulate working with formations where one aircraft peels away from the formation.

Aircraft Events:

Aircraft events are those events that change some characteristic or behavior for a specific aircraft. These events may be triggered by time, position, speed, altitude, heading, or as a crossing restriction.

Record/Replay:

Charter both records its own actions and serves as a repository for client replay information. Simulation exercises may be rewound to the beginning or to a specific point, they may then either be replayed or the simulation may be started from that point. This is extremely useful in a training environment, as an instructor may replay a student's actions to show where a problem started, then rewind again to just before that point and let the student work through the problem again.

Aircraft Motion:

Charter provides six degree of freedom simulation of airspace environments. An aircraft may move freely within the simulated world provided it operates within the valid operating parameters for that type of aircraft. Aircraft True, Indicated and Ground Speeds are maintained for each aircraft and adjusted appropriately for changes in altitude and wind speed/direction.

The motion for individual classes of aircraft is constrained by Charter. There are no arbitrary constraints on the number of classes of aircraft that may be defined.

The constraints are defined below:

- Minimum and Maximum Speeds
- Acceleration and Deceleration Rate Normal and Maximum Values
- Ascent and Descent Rate Normal and Maximum Values
- Turn Rate Normal and Maximum Values.
- Maximum Altitude

Aircraft Motion is also constrained by several explicit rules, such as limiting aircraft speed to 250 Nm/hr below 10000 feet. Provision is made for overriding these explicit rules on a per aircraft basis.

Aircraft Control:

Aircraft may be controlled either by pre-built event or by Pilot commands. In many cases, a single command is converted into a long sequence of automated behavior. For example, a command from the pilot to perform a Visual Approach following a lead aircraft causes the aircraft to react to the behavior of the leader while flying an approach and automatically landing. Many of the more complicated aircraft operations (such as crossing restrictions, approaches and landing) have been automated so the Pilot only needs to issue a single command.

Aircraft normally fly a Filed Flight Plan and react to events that have been placed on that flight plan, including altitude restrictions. Scenario developers may place events on flight plans to create specific training situations for students to handle, such as beacon code changes.

Pilots may change the behavior of an aircraft on a filed flight plan, put the aircraft onto an entirely new flight plan, or place the aircraft on vector. The pilot normally issues commands to change an aircraft's behavior in response to a student's issued instructions. However, a pilot may also issue commands based upon Pilot Prompts placed into the scenario by the scenario developer.

Approaches:

Three different basic types of approaches to airports are supported: full, straight-in and visual. Full and straight-in approaches may be flown from an ILS, a VOR, or based upon NDB. Visual Approaches may be direct to the airport or in-trail behind another aircraft on approach to the airport. In all cases, any activities such as flying of procedure turns, approach legs, speed changes, altitude changes, etc. are completely automated. The Pilot may modify this automated behavior through the use of speed and altitude commands.

For Visual Approaches, both distance and altitude differentials are used to compute visibility of a target.

Departures:

Departures are automated procedures as well. Once the Pilot has issued a Depart command, the aircraft automatically takes off, gains altitude and starts its filed flight plan, including any SID's which may appear on its route. The Pilot may issue commands to modify this automated behavior if so desired for instructional purposes.

Route Definition:

In the U.S. Domestic Air Traffic environment, there are a wide variety of options in defining a route for an aircraft. As far as possible, Charter has been built to support all of these options. For the first entry, Charter supports Fixes, FRD's (FixRadialDistance), Stereo Tags, or a transition.

Following this in any valid configuration may be:

- Fixes
- FRD's

- Radials
- Stereo Tags
- Lat/Long
- Asterisk following the departure or destination fix
- ETA information
- Delay information
- Plus prefix to another element
- Airways
- SIDs (Standard Instrument Departure)
- STARs (Standard Arrival Routes)
- Tailoring information
- Incomplete (XXX) marker
- VFR marker
- DVFR marker

Weather:

Weather is defined as a set of patterns with the constraint that only one pattern may be active at a given point in time. However, each weather pattern may contain zero or more weather cells, with each cell having different upper and lower altitude, heading and speed values.

Each weather cell consists of a set of points defining a boundary for the cell and zero or more heavy indicators. Intensities within a weather cell are defined on a grid basis with a grid size of 2 Nm. These intensities may vary from 1 (least intense) to 10 (most intense). As weather cells move, they may overlap and cause intensification within the overlapping grids. As the cells move apart, the intensities return to normal levels.

Although a degree of randomness for heading and speed is allowed within the scenario data, no randomness is implemented. Weather patterns move so slowly, it is doubtful such randomness would be noticed. It is also important to give each student a consistent training experience.

Winds:

Multiple layers, intensities, and directions of winds may be included in a scenario. These winds have a direct impact on the behavior and flight characteristics of aircraft. If an aircraft is flying into a strong head wind, its indicated air speed may be quite high, but its true air speed may be low. Likewise, an aircraft on vector with a strong side wind is blown to the side as it flies, and an aircraft flying a flight plan automatically makes constant heading corrections to compensate for wind. The simulation handles all of these wind effects.

Sectorization and Handoffs:

Charter supports multiple active sectors controlled by different students. The students may initiate and accept handoffs between sectors, as well as initiate handoffs to uncontrolled sectors. The simulation accepts handoffs to uncontrolled sectors automatically after a suitable delay for realism. Either the scenario developer or the Pilot may issue handoffs from the uncontrolled sectors to the active sectors.