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Space Administration

A stylized graphic for the SIMILABS logo. It features a black swoosh that forms a partial orbit around a central point. A red circle is positioned above the letter 'I'. To the right of the 'I', there is a semi-circular shape composed of a grid of blue and green squares, resembling a globe or a data visualization.

# SIMILABS

@NASA Ames Research Center



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# Building Airport Surface HITL Simulation Capability

FutureFlight Central



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# Outline

- SimLabs facilities
  - What is FutureFlight Central?
- Features and Capabilities
- Components of a Tower Simulation
- FFC Architecture and Visual Airport Model
- FFC Processes
  - Reconfigurable Image Generator (RiG)
  - Airspace Target Generator (ATG)
  - Ground Pilot Station User Interface
  - Connectivity
  - Out-the-window Image Generation
  - Audio System
- Data Collection
- HITL Simulation Process
- Summary





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# SimLabs Facilities

# Ames

Discovery → Innovations → Solutions

Unique facilities capable of a wide range of aerospace systems research

VMS



FFC



CVSRF







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# FutureFlight Central (FFC)





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# What is FutureFlight Central?

- National Air Traffic Control/Air Traffic Management test facility dedicated to solving the present and emerging challenges facing our national airspace system(NAS)
- Offers full-scale, real-time simulation of an airport where controllers, pilots and airport personnel participate to optimize expansion plans, augment operating procedures, and evaluate new technologies



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# Features and Capabilities (1)

- Visual Airport Model
  - 3D airport database model displayed on twelve projection screens provides 360-degree out-the-window view of the airport
- Multiple Views
  - Database supports views of the airport from any location





## Features and Capabilities (2)

- Real-time Traffic Simulation
  - Traffic scenarios encompass the terminal air space and airfield surface
- Radar Displays
  - Supports all air and ground positions controlling traffic: ASDE-X, DBRITE
  - Additional displays can be added to meet research requirements
- Built-in Voice Communications System
  - Can be configured to support all radio frequencies operating at an airport control tower





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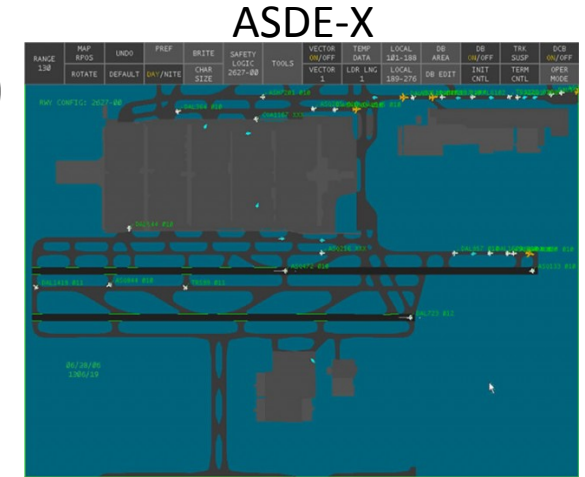


# Features and Capabilities (3)

- Data Recording
  - Collect measurements of surface performance for ground vehicles and aircraft, controller/pilot communications, and audio/video observational data
- Aircraft Library
  - Aircraft model database contains over 100 3D aircraft and ground vehicle models containing detailed liveries of airlines represented in the simulation

# Components of a Tower Simulation (1)

- Out the Window (OTW) display
  - Image Generator (IG)
  - Airport database
- Tower Controller Tools
  - Airport Surface Detection Equipment – Model X or ASDE-X
  - Digital Bright Radar Indicator Tower Equipment – DBRITE
- Target Generator
  - Traffic airborne /surface
- Communication system
- Data collection





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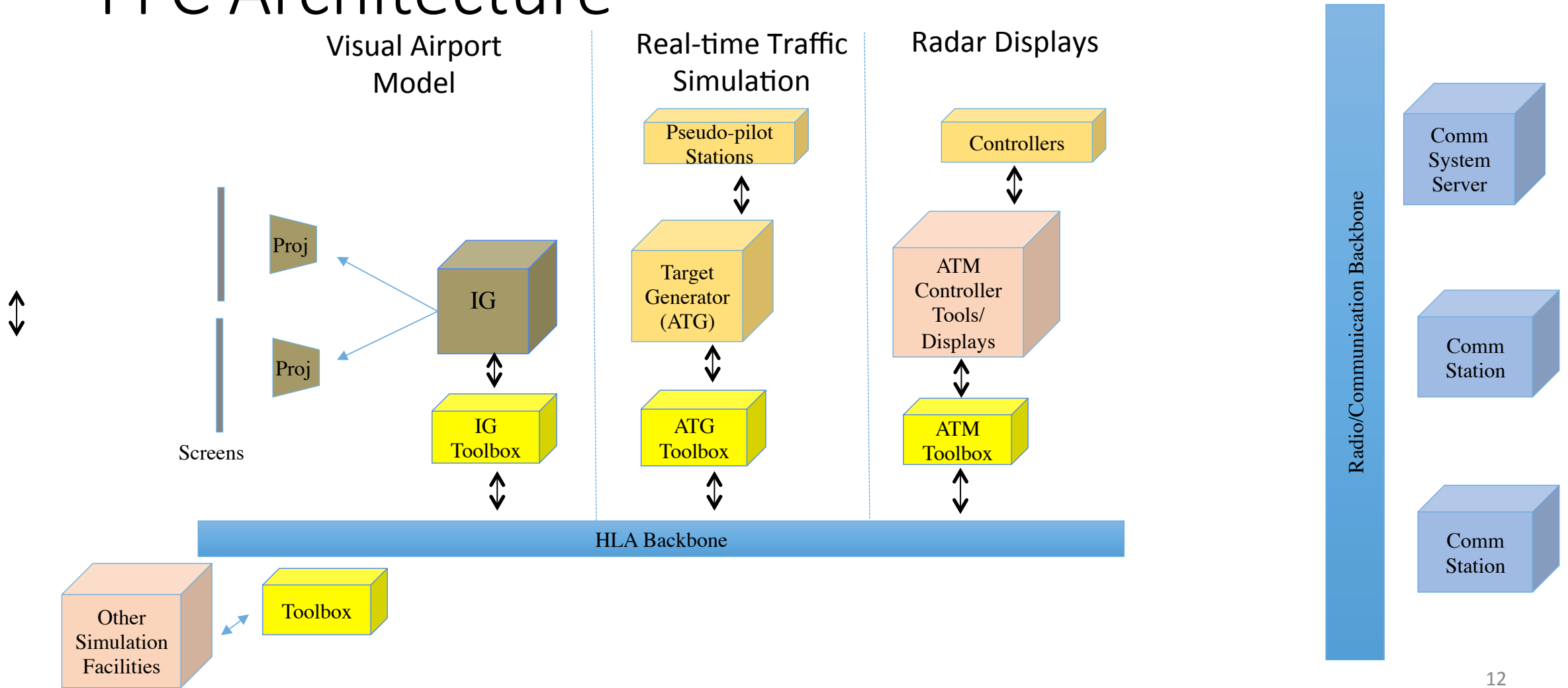
# Components of a Tower Simulation (2)

- Human operators:
  - Tower controller
  - TRACON controllers
  - Ramp controllers
  - Pseudo-pilots
  - Engineers to operate the simulation





# FFC Architecture





# Reconfigurable Image Generator (RiG)

- Provides real time, out-the-window renderings, allowing targets to be visualized in our simulation environment
- Is highly scalable and can run any number of rendering view ports allowing the eye point to change.
- Entities can be followed, tracked, and centered-on for a (non-cockpit) point-of-view matching that of the entity
- Dynamic weather generation:
  - Clouds, Rain, Lightning, sleet, snow
  - Time of Day and Night
- NASA Developed Tool
  - Flexibility and control over development of visual databases



# Airspace Target Generator (ATG) Components

- Simulation Manager
  - The simulation engine to drive targets (airborne and ground dynamics)
  - Configure region and traffic scenario
  - Validates input files and scenario files
  - Controls the activation of targets
  - captures state data for collection
  - Controls the simulation clock
- Ground Manager
  - Serves all the ground pilot stations
  - Performs anti-stacking, anti-collision capability
- Pilot Station
  - Provides GUI for pseudo-pilots to control targets
  - Required for datalink messages to be parsed and passed to targets
  - Provides situational awareness with a variety of state and ground parameters





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**Airspace Target Generator - Simulation Manager Initialization**

**ATG** ATG v5.3.3 29July2016 15:00  
32-bit Linux v2.6.32  
Adaptations updated as needed

Region : ZTL\_LL.region\_dir

Airport (1 only) :  CLT  CLT.edit

Aircraft List :

Some other list?

Uncertainty File :

Turn Around File :

Automatic Command Input is Disabled :

Wind Type?  1D  3D  PRS Wind file :

Some other wind file?

2nd Wind file :

Ground Wind?  Yes  No Magnitude (kts):

Simulation Update Rate:

Runtime Options :  Defaults are Off

Run history name :

Number of aircraft desired:

Provides FP's, Track, Passes DL commands

External Decision Support Systems

**Ground Manager, sim feed @ localhost** Verzion 7.160520 ... invoked Tue Apr 19 18:19:24 PDT 2016

Targets: 0 [0,0,0] SimTime: 00:00:00 (0)

**Console Log**

```

00:00:00 # Ground Manager Verzion 7.160520 ... invoked Mon Oct 24 09:46:32 PDT 2016
00:00:00 # Loaded 164 sector channels
00:00:00 #
ESTABLISHED Connection to ATG on localhost:8000
00:00:00 # GM version Verzion 7.160520 ...
296_16_46_32 Log reset at 298_09_46_35
00:00:00 # Settings are as follows:
-----
settings = input/settings_clt_off.txt
pathAdaptations = /vast/users/carla/testing/createAtg/
isDeveloper = true
simFeed = localhost
atgHome = notAvailable
airport = CLT in ZTL_LL.region_dir
simName = test
models = input/vehicleModels2014.txt
accelDecel = /input_files.dir/aircraft_performance.dir/aircraft_types_database
sectors = input_files.dir/ZTL_LL.region_dir/profiles.dir/sector_names
-----
00:00:00 # loaded airport CLT, version # Created Fri May 27 13:01:09 PDT 2016

```

Provides Track, DL commands, Notifications, CD&R

**Pilot Station # 2** Pilot Manager @ ffcplott5 sim feed @ localhost Verzion 7.160415 ... Invoked Tue Apr 19 18:19:24 PDT 2016

Targets: 84 [Departures 74(50kts) Arrivals 4(9kts) OnFinal 2 | Airborne 4 | SimTime: 00:2:53 (1383)]

**Target List**

| State   | Spot      | Runway | Calign  | Gate      |     |
|---------|-----------|--------|---------|-----------|-----|
| Hold    | 24        | 36R    | AAL1925 | C10       |     |
| Hold    | 25        | 36R    | AAL2900 | C12       |     |
| Taxi    | 5...      | 24     | 36R     | AAL1830   | C14 |
| Hold    | 2...      | 24     | 36R     | AAL2011   | C4  |
| Hold    | 2...      | 24     | 36R     | AAL2812   | O6  |
| Airport | noAirport | -1     | AAL1770 | noAirport |     |
| Hold    | 24        | 36R    | AAL871  | D1        |     |
| Taxi    | ...       | 24     | 36R     | AAL840    | D11 |
| Hold    | 24        | 36R    | AAL1565 | D13       |     |
| Hold    | 24        | 36R    | AAL915  | D5        |     |
| Hold    | 24        | 36R    | AAL1709 | D9        |     |
| Hold    | 24        | 36R    | AAL829  | D5        |     |
| Taxi    | ...       | 24     | 36R     | AAL883    | D7  |
| Hold    | 24        | 36R    | AAL1062 | D9        |     |

**State View**

Knobs:  
Seats:  
Destination:  
Gate:  
Runway:

**Cmd Keys**

- F5: STOP
- F6: GO
- F7: FlightWay
- F8: Clear\_Rte
- F9: Taxi Perimeter 2500/Spot on IFS Spot 3

**Notifications 8**

- NOTIFY Controller [1] AAL1770 Ready to Push off
- NOTIFY Controller [3] AAL1830 Ready to Push off
- NOTIFY Controller [1] AAL1770 Ready to Taxi
- NOTIFY Controller [3] AAL1930 Ready to taxi
- NOTIFY Controller [28] AAL840 Ready to Push off
- NOTIFY Controller [28] AAL840 Ready to taxi
- NOTIFY Controller [28] AAL829 Ready to Push off
- NOTIFY Controller [29] AAL883 Ready to Push off

**Commander**



# Ground Pilot Station User interface

- Ground maps are tightly coupled to the visual system
- Two different map views are supported for each station
- Configurable set of data per each Flight
  - Flight list
  - Status list for a single flight
  - Icon tags
- Configurable set of panels (location, scale, on/off)
- Variety of ways to input or control targets
  - Commander Panel (buttons, menus)
  - Hot Keys Panel (customizable commands)
  - Text Entry Panel



# Example Pilot Station Ground MAP and User Interface

Pilot Station # 2 Pilot Manager @ ffc pilot5 sim feed @ localhost Verzion 7.160415 ... invoked Tue Apr 19 18:19:24 PDT 2016

System Map Target Help

Map: CLT

Targets: 84 | Departures 74(150kts) | Arrivals 4(94kts) | OnFinal 2 | Airborne 4 | SimTime: 00:23:03 (1383)

| State               | Spot | Runway  | Callsign   | Gate |
|---------------------|------|---------|------------|------|
| Held @...           | 24   | 36R     | AAL1925    | C10  |
| Held @...           | 25   | 36R     | AAL1910    | C12  |
| Taxi ...            | 24   | 36R     | AAL1830    | C14  |
| Held @...           | 24   | 36R     | AAL2013    | C4   |
| Held @...           | 24   | 36R     | AAL1832    | C6   |
| Airborne noA1 rport | -1   | AAL1770 | noA1 rport |      |
| Held @...           | 24   | 36R     | AAL852     | 01   |
| Taxi ...            | 24   | 36R     | AAL840     | 011  |
| Held @...           | 24   | 36R     | AAL1965    | 013  |
| Held @...           | 24   | 36R     | AAL835     | 02   |
| Held @...           | 24   | 36R     | AAL1709    | 03   |
| Held @...           | 24   | 36C     | AAL829     | 05   |
| Taxi ...            | 24   | 36R     | AAL893     | 07   |
| Held @...           | 24   | 36R     | AAL1982    | 09   |

State View

Knots:  
State:  
Destination:  
Gate:  
Runway:

Cmd Keys

|    |                                      |
|----|--------------------------------------|
| F5 | STOP                                 |
| F6 | GO                                   |
| F7 | RightOfWay                           |
| F8 | Clear_Rte                            |
| F9 | Taxi Perimeter2Sp9/Spot9e JHS Spot23 |

Notifications 8

- NOTIFY Controller [1] AAL1770 Ready to Push off
- NOTIFY Controller [5] AAL1830 Ready to Push off
- NOTIFY Controller [1] AAL1770 Ready to taxi
- NOTIFY Controller [5] AAL1830 Ready to taxi
- NOTIFY Controller [28] AAL840 Ready to Push off
- NOTIFY Controller [28] AAL840 Ready to taxi
- NOTIFY Controller [26] AAL829 Ready to Push off
- NOTIFY Controller [29] AAL883 Ready to Push off

Commander

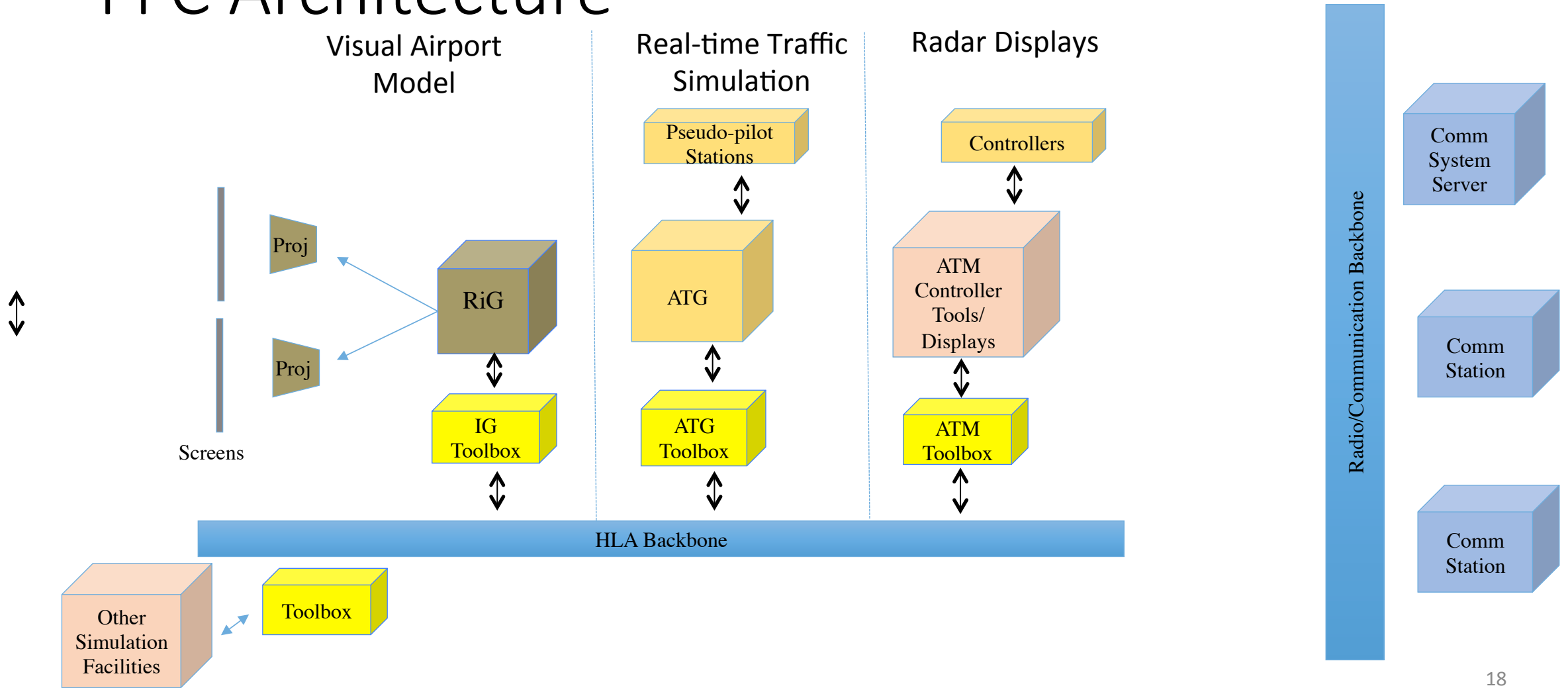
ground : run\_script Pilot Station # 2 Pilot Mana

18:40





# FFC Architecture





# Connectivity (1)

- High Level Architecture (HLA)
  - A technology for developing distributed systems
  - An open international standard, developed by the Simulation Interoperability Standards Organization (SISO) and published by IEEE
  - A document of standards that describes the components of HLA and what interfaces and properties they must have. Anyone can develop any software component of HLA.
  - Its topology is a number of systems that have one single connection to a service bus that is called the Runtime Infrastructure (RTI)



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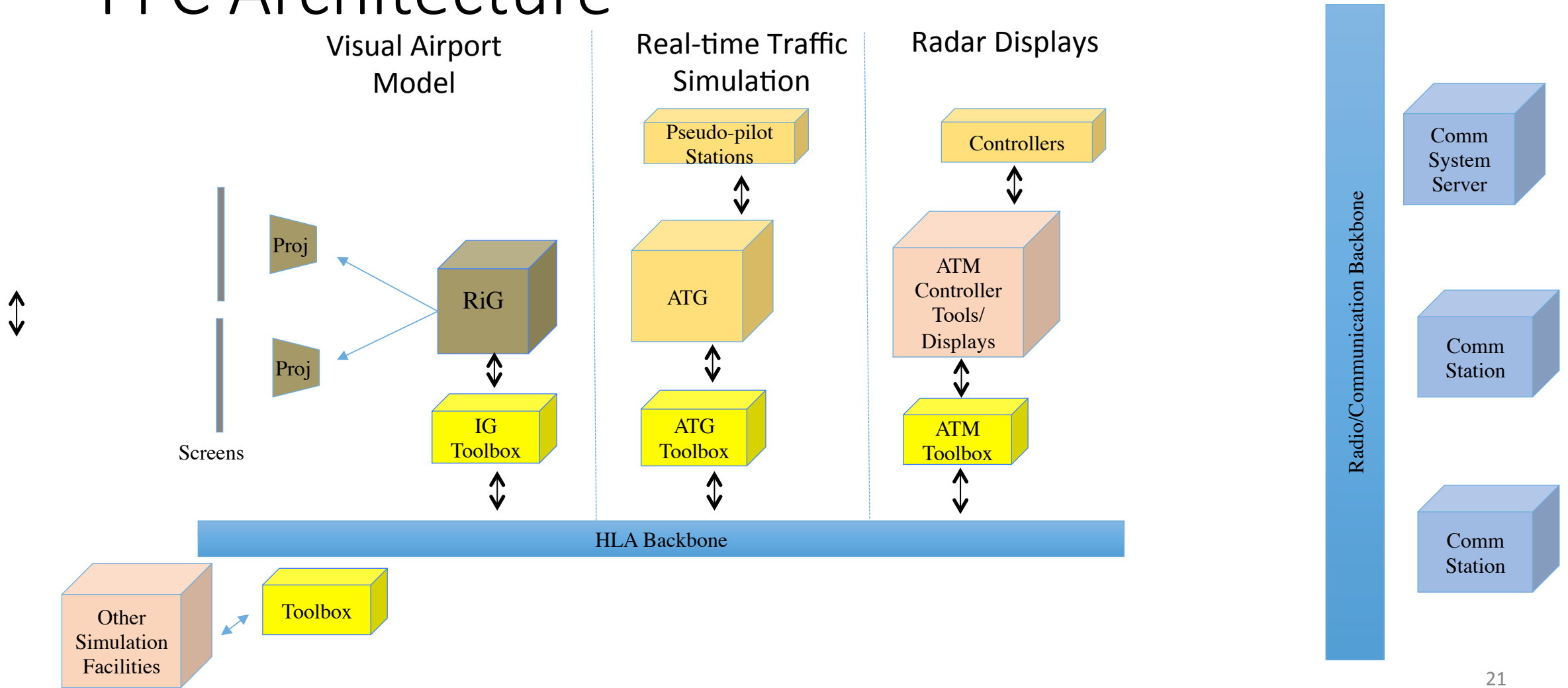


## Connectivity (2)

- Pitch RTI
  - Runtime Infrastructure - Software that provides the HLA service bus. The RTI provides information, synchronization, and coordination services.
- RiG Toolbox
  - Paired interfaces to connect the RIG to the HLA service bus
- ATG Toolbox
  - Interface between ATG and the HLA service bus



# FFC Architecture







# Out-the-Window Image Generation (1)

- 3D database/airport map generation
  - 3D sources
    - Computer Aided Design drawings, Google Earth, FAA or researcher supplied
  - Stationary models, Moving models / Aircraft Models
  - 3D database development in “creator”
- Convert 3D model for use in Image Generator(RiG)
- Import 2D map to ATG (Airspace Target Generator)
  - Conversion or layers of 3D database to 2D image for use in Target Generator
  - Generating airport map in ATG
- Ground Route Development in ATG



# Out-the-Window Image Generation (2)

- Scenario Development
  - Research airport operations:
    - Number of arrivals, departures, airport operations
    - Fleet mix, airline mix
    - Gate utilization
    - Ground routes
    - [Standard Instrument Departure](#) (SID)
    - [Standard Terminal Arrival Route](#) (STAR)
- Alignment between ATG and visuals



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# Audio System

- Voice communication at each station
- Touch screen with multiple frequencies
- Radio, telephone, direct dial, intercom emulation
- Record/playback capability
- Used for communication between pseudo-pilots and controllers
- Separate channel for coordination by FFC staff



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# Data Collection

- Airport statistics
- Out-the-window screen capture
- Audio and Video recordings
  - Communications and cameras at the controllers
- Workload assessment
- Surveys
- Other
  - Blood pressure
  - Heart rate





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# HITL Simulation Process

1. Requirements from the researchers
2. Design system architecture
3. Development and internal testing
4. Integration testing
5. Train external participants on the simulator and the ATM tools
6. HITL simulation
7. Data collection



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# FutureFlight Central

- Test bed for new concepts and technologies
  - Technologies evaluated with realistic air traffic operations in a safe environment
  - Repeatable off-nominal or infrequent cases per research requirements
- Tool for surface operations human factors research
  - Controllers are able to interact with new tools
  - Data capture and analysis demands for human in the loop simulations
- Evaluation of proposed airport physical and procedural modifications
  - New proposed structures such as runways, buildings, or taxiways can be added to the existing visual database of an airport



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# Air Traffic Generator

External Decision Support Systems

Provides FP's, Track, Passes DL commands

**ATG** v5.3.3 29July2016 15:00  
32-bit Linux v2.6.32  
Adaptations updated as needed

Region : ZTL\_LL.region\_dir

Airport (1 only) :  CLT  CLT.edit

Aircraft List : Arrivals\_NFlow

Some other list? :

Uncertainty File : No files available!

Turn Around File : OFF

Automatic Command Input is Disabled : List...

Hind Type?  1D  3D  PRS Hind file : zero.default

Some other wind file? :

2nd Wind file : zero.default Update Wind File Time (sec):

Ground Hind?  Yes  No Magnitude (kts): Direct

Simulation Update Rate: 1 Second ATC-System Update Rate:

Runtime Options : Select... Defaults are Off

Run history name :

Number of aircraft desired: all

Ground Manager, sim feed @ localhost Verzion 7.160520 ... invoked Mon Oct 24 09:46:32 PDT 2016

Targets: 0 [0,0,0] SimTime: 00:00:00 (0)

Console Log

```

00:00:00 # Ground Manager Verzion 7.160520 ... invoked Mon Oct 24 09:46:32 PDT 2016
00:00:00 # Loaded 164 sector channels
00:00:00 #
ESTABLISHED Connection to ATG on localhost:8000
00:00:00 # GM version Verzion 7.160520 ... invoked Mon Oct 24 09:46:32 PDT 2016
296_16_46_32 Log reset at 298_09_46_35
00:00:00 # Settings are as follows:
-----
settings = input/settings_clt_off.txt
pathAdaptations = /vast/users/carla/testing/createAtg/
isDeveloper = true
simFeed = localhost
atgHome = notAvailable
airport = CLT in ZTL_LL.region_dir
simName = test
models = input/vehicleModels2014.txt
accelDecel = /input_files.dir/aircraft_performance.dir/aircraft_types_database
sectors = input_files.dir/ZTL_LL.region_dir/profiles.dir/sector_names
-----
00:00:00 # loaded airport CLT, version # Created Fri May 27 13:01:09 PDT 2016
  
```

Provides Track, DL commands, Notifications, CD&R

Pilot Station # 2 Pilot Manager @ frcpilots sim feed @ localhost Verzion 7.160415 ... invoked Tue Apr 19 18:19:24 PDT 2016

Targets: 84 | Departures 74(50kto) | Arrivals 4(4kto) | OnFinal 2 | Airborne 4 | SimTime: 00:2:30.1 (1383)

Map: CLT

| State     | Spot     | Runway | Calign  | Gate     |
|-----------|----------|--------|---------|----------|
| Hold B... | 24       | 36R    | AAL1725 | C10      |
| Hold B... | 25       | 36R    | AAL1590 | C12      |
| Taxi S... | 24       | 36R    | AAL1830 | C14      |
| Hold B... | 24       | 36R    | AAL2013 | C11      |
| Hold B... | 24       | 36R    | AAL1892 | C6       |
| Airborne  | holdrprt | -1     | AAL1770 | holdrprt |
| Hold B... | 24       | 36R    | AAL922  | D1       |
| Taxi T... | 24       | 36R    | AAL840  | D11      |
| Hold B... | 24       | 36R    | AAL865  | D10      |
| Hold B... | 24       | 36R    | AAL935  | D5       |
| Hold B... | 24       | 36R    | AAL1709 | D3       |
| Hold B... | 24       | 36R    | FA9309  | D5       |
| Taxi T... | 24       | 36R    | AAL883  | D7       |
| Hold B... | 24       | 36R    | AAL1562 | D9       |

State View

Notifications 8

- NOTIFY Controller [1] AAL1770 Ready to Push off
- NOTIFY Controller [3] AAL1830 Ready to Push off
- NOTIFY Controller [1] AAL1770 Ready to taxi
- NOTIFY Controller [3] AAL1830 Ready to taxi
- NOTIFY Controller [28] AAL840 Ready to Push off
- NOTIFY Controller [28] AAL840 Ready to taxi
- NOTIFY Controller [26] AAL820 Ready to Push off
- NOTIFY Controller [26] AAL820 Ready to taxi
- NOTIFY Controller [29] AAL883 Ready to Push off



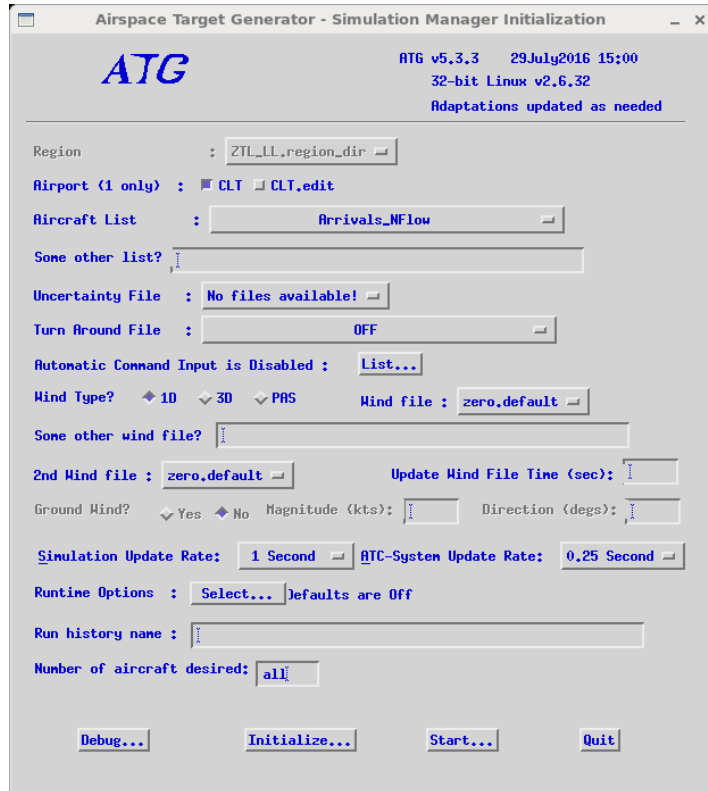
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# Agenda

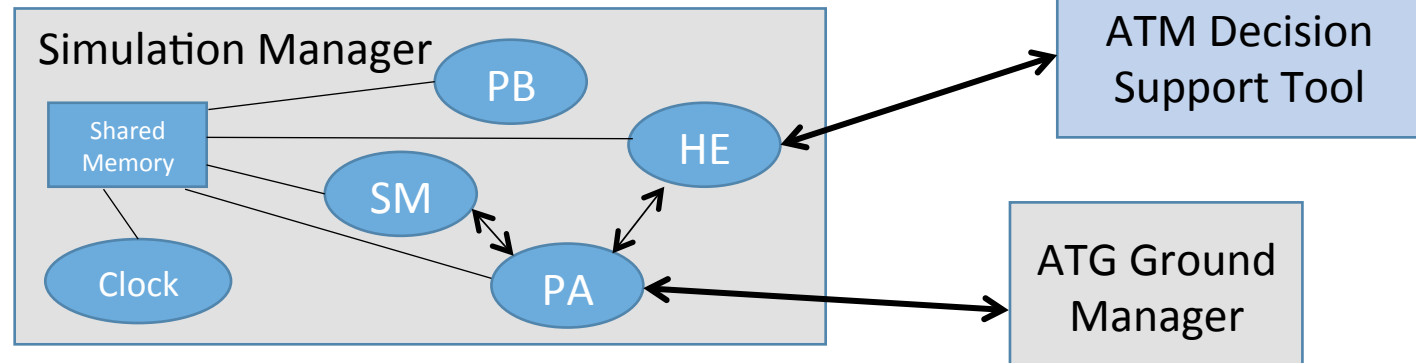
- Simulation Manager
- Ground Manager
- Pilot Stations
  - Input files
  - User Interface and Control
  - Edit mode





# Simulation Manager

- The simulation engine to drive targets (airborne and ground dynamics)
- Configure region and traffic scenario
- Validates input files and scenario files
- Controls the activation of targets
- Captures state data for collection
- Controls the simulation clock





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# Dynamics

## Airborne

- 4 DOF (x,y,z plus roll for directional control)
- great circle navigation equations
- designed for commercial fleet mix performance characteristics

## Ground

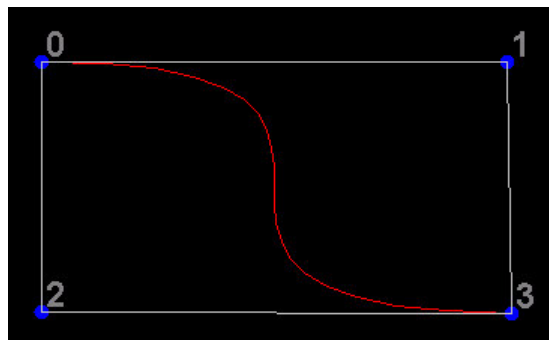
- 2 DOF (flat airport, rectangular coordinates)
- Cubic Bezier curves define the path (aircraft ride on a rail)
- Kinematic modeling for speed control (linear)



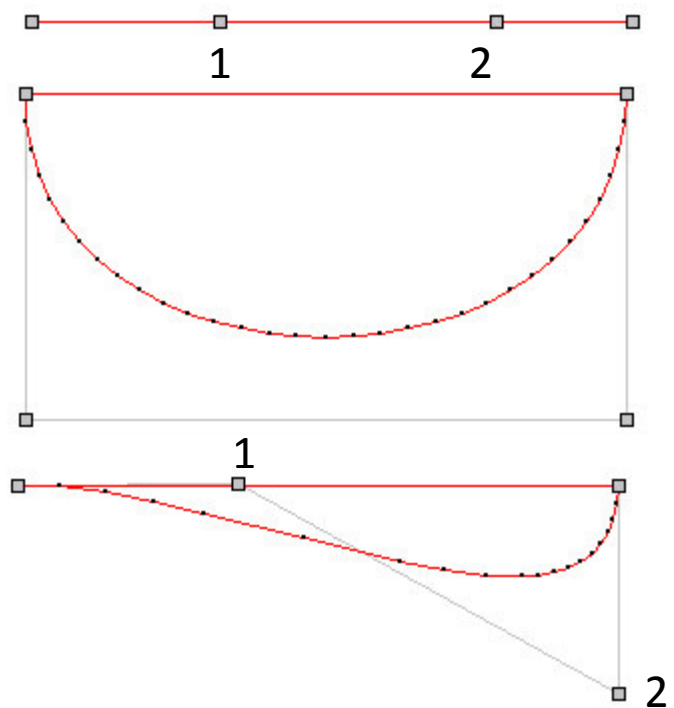
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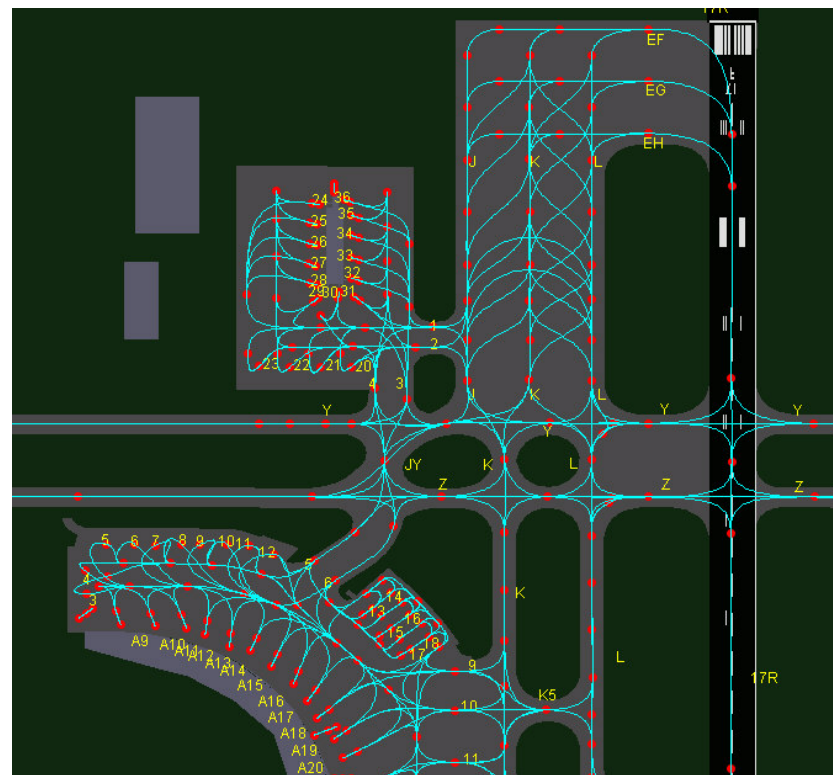
# Cubic Bezier Curves



Control Nodes 1 and 2 define the shape of the curve



As seen in the Surface Pilot Station





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# Files Required for Running

- Adaptation
  - Airport (maps, routes)
  - Airspace (STAR's, SID's, etc.)
  - Sector definitions
- Scenario
  - Aircraft List
  - Turnaround Departure List (optional)
  - Command files (optional)
- Aircraft Performance Files
- Weather (if not selected, then standard day, calm air)





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# Aircraft List

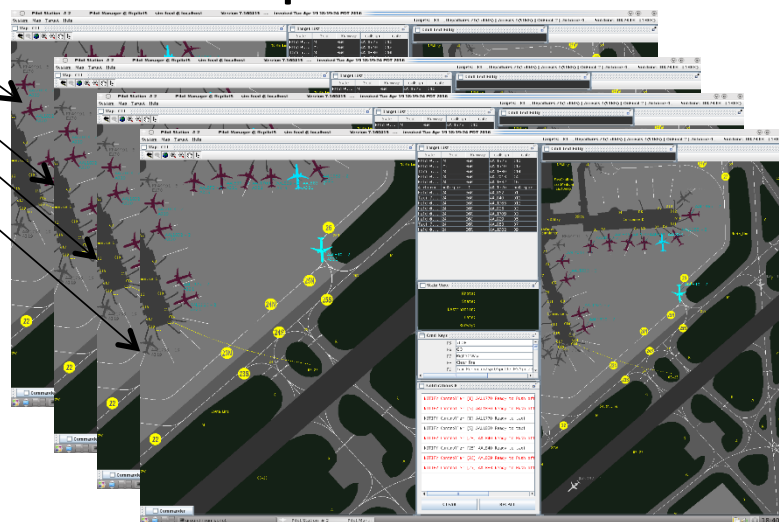
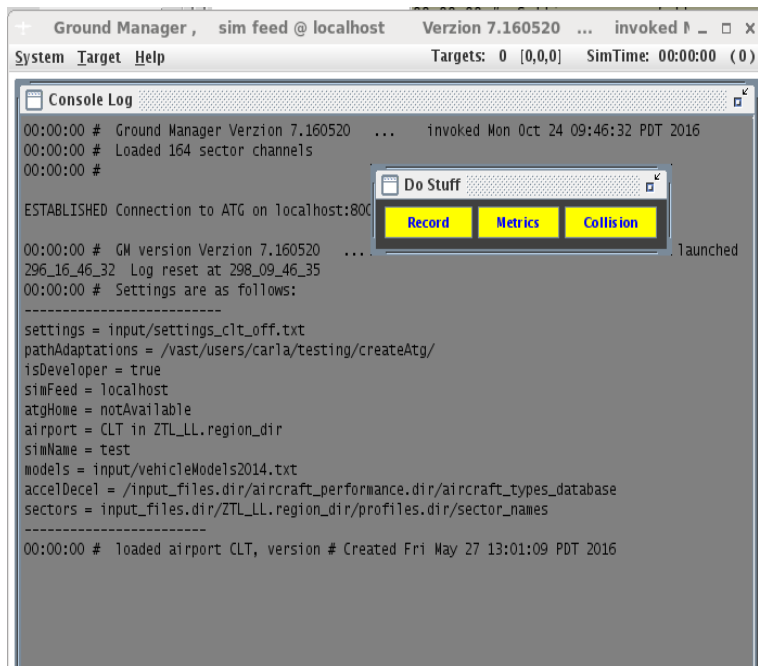
| Column Item  | Description            | Arrival Example | Departure Example | Req/Opt  |
|--------------|------------------------|-----------------|-------------------|----------|
| flRules      | Flight Rules           | IFR             | IFR               | Req'd    |
| flStatus     | flight Status          | RTE             | GRD               | Req'd    |
| callsign     | Callsign               | AAL1733         | AAL1889           | Req'd    |
| tailNumber   | Tail identifier        | N201UU          | N741UW            | Optional |
| acType       | Aircraft Type (FAA id) | B752            | A319              | Req'd    |
| initAirspeed | Filed or Init airspeed | 170             | 280               | Req'd    |
| initAltitude | Filed or Init altitude | 40              | 330               | Req'd    |
| depAirport   | Departure Airport      | PHL             | CLT               | Req'd    |
| destAirport  | Destination Airport    | KCLT            | LGA               | Req'd    |
| depRunway    | Departure Airport      | NOT_SET         | 18L               | Optional |
| destRunway   | Destination Airport    | 18R             | NOT_SET           | Req'd    |
| gate         | Gate Assignment        | gateB11         | gateC19           | Optional |
| spot         | Spot Assignment        | NOT_SET         | Spot26S           | Optional |
| entryTime    | Activation Time        | P6946           | P40               | Req'd    |

| Column Item        | Description                 | Arrival Example                    | Departure Example                      | Req/Opt  |
|--------------------|-----------------------------|------------------------------------|--|----------|
| fpSta              | Wheels down                 | 7186                               | NOT_SET                                | Optional |
| pbSchedTime        | Pushback scheduled          | NOT_SET                            | 1390                                   | Optional |
| pbTime             | Pushback Pilot Notification | NOT_SET                            | 1484                                   | Optional |
| sectorId           | Sector Assignment           | 18CE5                              | rampS                                  | Req'd    |
| pilotId            | Pilot Assignment (1-33)     | 7                                  | 13                                     | Optional |
| startPoint         | Activation Position         | HAGUL                              | gateC19                                | Req'd    |
| magHeading         | magnetic Heading            | NOT_SET                            | NOT_SET                                | Depends  |
| defaultTaxiSpd     | default Taxi Spd            | 16                                 | 17                                     | Optional |
| defaultRampSpd     | default Ramp Spd            | 8                                  | 9                                      | Optional |
| defaultPushbackSpd | default Pushback Spd        | 3                                  | 4                                      | Optional |
| spoolUpTime        | spool Up Time               | 42                                 | 46                                     | Optional |
| atgFlightPath      | ATG flight plan             | HAGUL..KCLT                        | KCLT.BARMY1.RDU./.<br>KLGA             | Req'd    |
| nasFlightPath      | ATC Filed Flight Plan       | KPHL./..HVQ..LNDIZ.P<br>ARQR2.KCLT | KCLT./..KCLT.BARMY1<br>.RDU..HPW..KLGA | Optional |



# Ground Manager

- Serves all the ground pilot stations
- Performs anti-stacking, anti-collision capability
- Monitors connections
- Ability to record and playback states captured
- Serves up to 33 stations





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# Conflict Detection and Resolution



# Example Pilot Station Ground MAP and User Interface

Pilot Station # 2 Pilot Manager @ ffcpiot5 sim feed @ localhost Verzion 7.160415 ... Invoked Tue Apr 19 18:19:24 PDT 2016

System Map Target Help Targets: 84 [ Departures 74(150kts) | Arrivals 4(94kts) | OnFinal 2 | Airborne 4 ] SimTime: 00:23:03 (1383)

Map: CLT

| State              | Spot | Runway  | Callsign  | Gate |
|--------------------|------|---------|-----------|------|
| Hold @...          | 24   | 36R     | AAL1925   | C10  |
| Hold @...          | 25   | 36R     | AAL1910   | C12  |
| Taxi 5...          | 24   | 36R     | AAL1830   | C14  |
| Hold @...          | 24   | 36R     | AAL2012   | C4   |
| Hold @...          | 24   | 36R     | AAL1832   | C6   |
| Airborne noAirport | -1   | AAL1770 | noAirport |      |
| Hold @...          | 24   | 36R     | AAL852    | D1   |
| Taxi 7...          | 24   | 36R     | AAL840    | D11  |
| Hold @...          | 24   | 36R     | AAL1965   | D13  |
| Hold @...          | 24   | 36R     | AAL835    | D2   |
| Hold @...          | 24   | 36R     | AAL1709   | D3   |
| Hold @...          | 24   | 36C     | AAL829    | D5   |
| Taxi 7...          | 24   | 36R     | AAL883    | D7   |
| Hold @...          | 24   | 36R     | AAL1962   | D9   |

State View

Knots:  
State:  
Destination:  
Gate:  
Runway:

Cmd Keys

|    |                                      |
|----|--------------------------------------|
| F5 | STOP                                 |
| F6 | GO                                   |
| F7 | RightOfWay                           |
| F8 | Clear_Rte                            |
| F9 | Taxi Perimeter2Sp9/Spot9e [HS Spot23 |

Notifications 8

- NOTIFY Controller [1] AAL1770 Ready to Push off
- NOTIFY Controller [5] AAL1830 Ready to Push off
- NOTIFY Controller [1] AAL1770 Ready to taxi
- NOTIFY Controller [5] AAL1830 Ready to taxi
- NOTIFY Controller [28] AAL840 Ready to Push off
- NOTIFY Controller [28] AAL840 Ready to taxi
- NOTIFY Controller [26] AAL829 Ready to Push off
- NOTIFY Controller [29] AAL883 Ready to Push off

Commander

ground : run\_script Pilot Station # 2 Pilot Mana

18:40





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## Map DXF Layers (Up to 10)

- Buildings
- Runways
- Taxiways
- Ramp
- Center Lines
- Hold Short Lines
- Runway Markings
- Misc.
  - Water, roads, no engine start lines, sector boundary, Outer Markers, etc.



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# Ground Route Definition Files

- Vertex
  - Nodes (10 types supported for routes)
  - Labels (type 55, 56)
- Segments
  - Bezier Curve parameters
- Runways
  - name, elevation, true heading, touchdown node
- Ramp
  - pre-defined routes from spot to gate & gate to spot
- Canned Routes
  - All AMA taxiways
  - Runways
  - Custom routes



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## Super Station vs. Normal Pilot Station

- Ability to control ALL targets
- Sees All notifications
- Can take over control other pilots flights
- Configurable for supporting a sector and pilot assignment
- Only controls those assigned
- Notifications for controlled flights only
- Can “take” an uncontrolled flight



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# Ground Pilot Station User Interface

- Ground maps are tightly coupled to the visual system
- Two different map views are supported for each station
- Configurable set of data per each Flight
  - Flight list
  - Status list for a single flight
  - Icon tags
- Configurable set of panels (location, scale, on/off)
- Variety of ways to input or control targets
  - Commander Panel (buttons, menus)
  - Hot Keys Panel (customizable commands)
  - Text Entry Panel
  - Point and click on the Map





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# Types of Control

## Ground

- Speed
- Pushbacks
- Full taxi clearances with holds
- Partial taxi clearances
- Stop/Go
- Cleared for Departure
- Adding holds

## Airborne

- Speed
- Heading
- Altitude
- Cleared for Arrival
- Full taxi clearances with holds
- Partial taxi clearances



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# Datalink Clearances

- Free text format
- Supports most Ground Clearances
  - Taxi
    - Can be short or complete from rwy to gate, rwy to spot, etc.
    - Can include Hold Shorts
  - Cleared for Approach, Cleared for Departure
  - Clear Next Hold
  - Gate change
  - Runway change
- Driven from external ATM processes
- Pilot Station can Auto Accept or Manually Accept



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# Aircraft Performance Parameters

- Speed definitions
  - Straight, curves
  - Runway
  - Pushback
  - Ramp
- Accelerations
  - taxiways
  - Runways
- Times
  - On gate before turn around can occur
  - Spool up
- Aircraft length
  - Used for holding short, CD&R, spacing

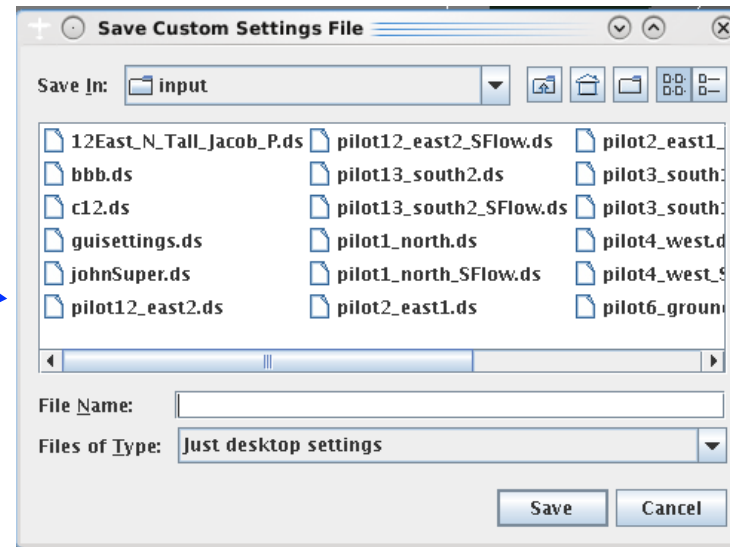
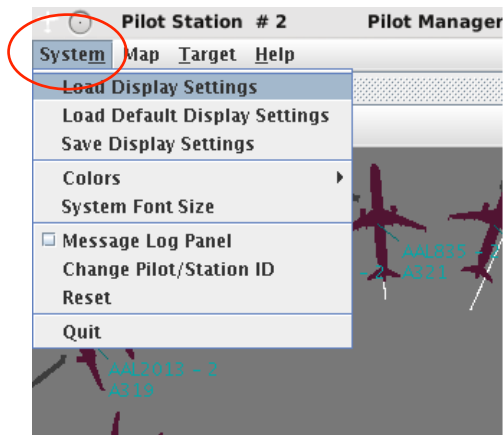
# Map Tool Bar Control



- Back Arrow/Fwd Arrow: Previous View/ Last View
- Globe: R-centers the map about the airport
- Magnifying Glass: + Zoom in / - Zoom out
- Pointer: Left-Click – Select (aircraft or point on route)  
Right-Click – Execute route
- Hand: Move viewpoint (right-click to zoom in / zoom out)

Right click on map background to get Arrow (Pointer) back.

# Loading and Saving Configurations







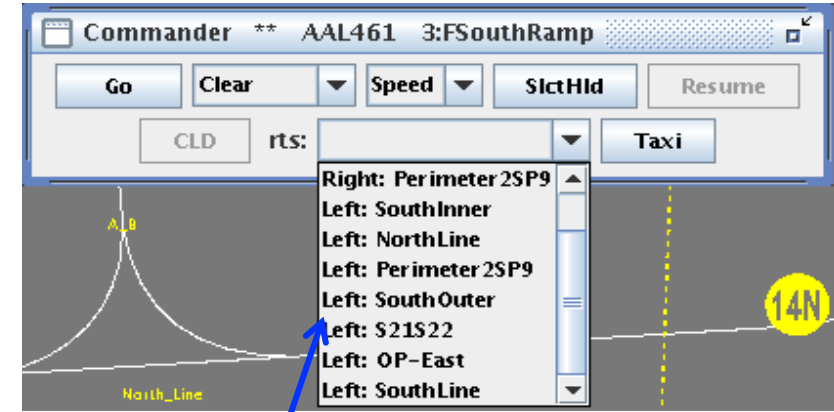
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# Command Entry Options

## Commander Panel

- Stop/Go
- Clear [next/all] holds
- Speed (menu in kts)
- SlctHld (hold point selection)
- Resume (default speed)
- CLD (cleared for departure)
- Rts (menu of canned routes relevant to the location and orientation of the selected aircraft and its current route)
- Taxi (executes proposed taxi clearance as does a right click)



## Command (Hot) Key Panel

| Key       | Command   |
|-----------|---|
| F5        | STOP  |
| F6        | GO  |
| F7        | RightOfWay  |
| F8        | CLEAR RTE   |
| F9        | Taxi Perimeter2Sp2/Spot2  HS rmp2 11  HS Spot2          |
| F10       |   |
| F11       | Taxi OP-East/M/Taxi49  HS Taxi5 1                       |
| F12       | Taxi OP-East/ M/C/C12  HS Spot8  HS C10  HS C11  HS C12 |
| INSERT    | HO 131.6/3  |
| HOME      | HO 129.8/4  |
| PAGE_UP   | HO 131.6/13   |
| DELETE    | CNH   |
| END       | HO 129.225/2  |
| PAGE_DOWN | HO 121.80/6   |

## Command Text Entry Panel

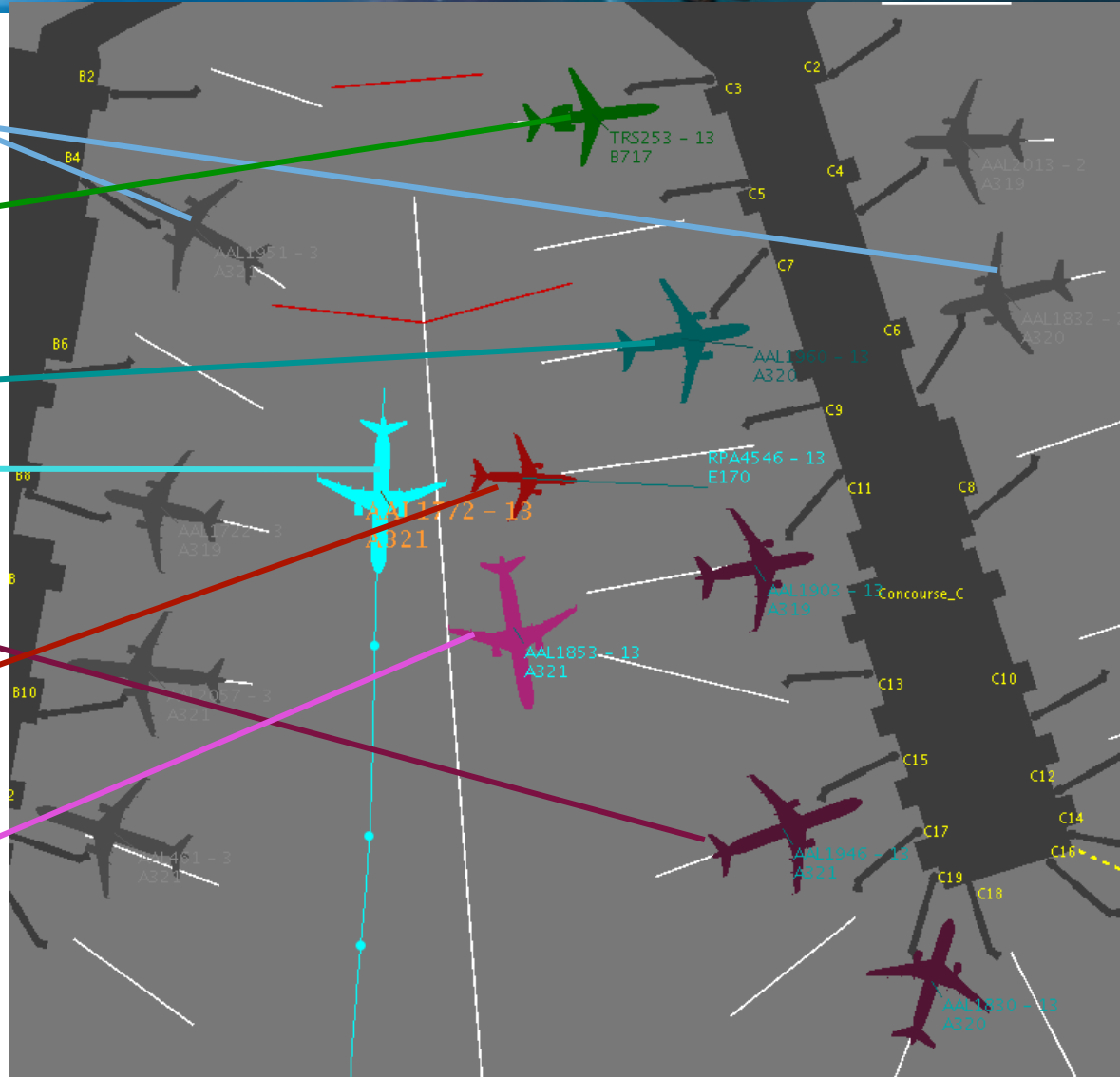




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- UnOwned
- Arrival Owned, Parked
- Departure Owned, No Route
- Departure Moving
- Departure Held @ Gate
- Stopped
- Held Enroute



Icon Color Key



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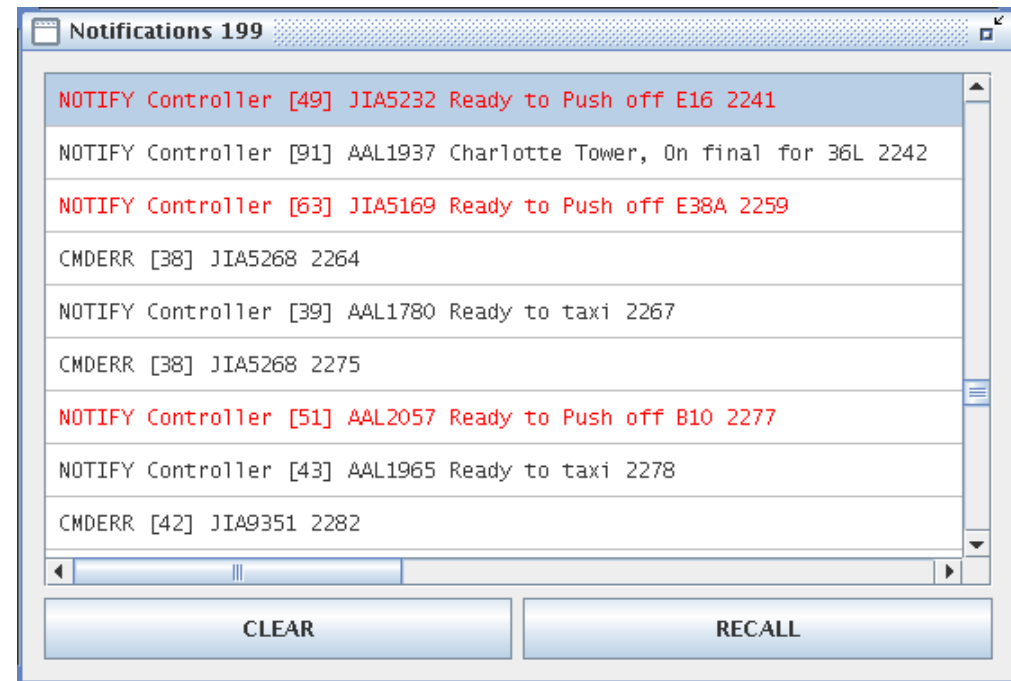


# Notifications Panel

Notifications come in top to bottom chronologically and should generally be handled in a FCFS fashion.

Clicking on a notification selects the aircraft to which that notification pertains.

Clear the notification once it is handled. An empty list is a good list. Use the CLEAR button on the Notifications Panel or the “Clear Message” function key.



# Flight Information Displays

## Single Flight Status Panel

State View

Callsign:

Controller:

Knots:

Destination:

Gate:

Spot:

Runway:

PbReadyTime:

## Target List Status Panel

| Callsign | PbR... | Knots  | State                   | Gate | Spot | Run... |
|----------|--------|--------|-------------------------|------|------|--------|
| TRS253   | 75     | 0      | Parked @ C3             | C3   | 13   | 23     |
| TRS353   | 95     | 0      | Held on TAXI52_SPOT23S  | D5   | 13   | 23     |
| AAL1772  | 339    | 2 -> 8 | Taxi 6730ft to 234      | B6   | 9W   | 18C    |
| RPA4546  | 871    | 0      | Stopped before RMP133   | C9   | 9W   | 18C    |
| AAL1960  | 1307   | 0      | Parked @ C7             | C7   | 26S  | 18L    |
| AAL1853  | 1919   | 0      | Spool for 28 sec & Held | C13  | 26S  | 18L    |
| AAL1830  | 3178   | 0      | Held @ GATEC19          | C19  | 26S  | 18L    |
| AAL1946  | 3746   | 0      | Held @ GATEC15          | C15  | 9W   | 18C    |
| AAL1903  | 4267   | 0      | Held @ GATEC11          | C11  | 26S  | 18L    |

Pilot Station # 2 Pilot Manager @ ffcpiot5 sim feed @ localhost Verzi

System Map Target Help

Map: Map: CLT Tags Tags Font Size Orientation

<alt> Map: CLT Surface Info Arrivals Data Block Departures Data Block

✓ Show Second Map Go To ...

Reset Tag Positions

Callsign  
 Owner  
 Pilot  
 Controller  
 Channel  
 Call:Pilot  
 Knots  
 State  
 Hold  
 MagHead  
 Altitude  
 LatAccel  
 Location  
 Destination  
 Gate  
 Spot  
 RwyEntry  
 Runway  
 Class  
 delta-S  
 ETA  
 PbReadyTime  
 DepartureFix  
 CID

Tag Menu List





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# Pilot Station Configured for Edit Mode

Taxiway Tool version 2.0 released 31 December 2008

System Map Target Help 0 Targets [ Departures 0 (0kts) | Arrivals 0 (0kts) | OnFinal 0 | Airborne 0 ] SimTime: 00:00:00 (0)

Map: CLT

Point View

Type: QUEUE

Name: TAXI225

ATG Coordinate

X: 541.00 Longitude: 0 0 5.337

Y: 131.00 Latitude: 0 0 1.292

On taxiways: D

Segment Info For: TAXI226

Segment View

Start Point: TAXI225

End Point: TAXI226

Initial Heading: 127

Final Heading: 175

Control 1 distance: 78

Control 2 distance: 97

Max Curvature: 0.0076

Avg Curvature: 0.0039

ArcLength S,RK 11: 252.26

ArcLength S,RK 101: 234.76

ArcLength S,RK 1001: 233.01

ArcLength S,RK 10001: 232.83



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# Edit Mode

Taxiway Tool version 2.0 released 31 December 2008

System Map Target Help 0 Targets | Departures 0 (0kts) | Ar

Map: CLT

View

Type: RAMP

Name: RMP451

| ATG Coordinate |                       | Degs Mins Secs |  |  |
|----------------|-----------------------|----------------|--|--|
| X: -1,129.00   | Longitude: 0 0 11.138 |                |  |  |
| Y: -2,223.00   | Latitude: 0 0 21.931  |                |  |  |

On taxiways: Southinner

ment Info For: RMP458

Segment View

Start Point: RMP451  
End Point: RMP458

Initial Heading: 48  
Final Heading: 45

Control 1 distance: 100  
Control 2 distance: 103

Max Curvature: 0.0124  
Avg Curvature: 0.0077

ArcLength S,RK 11: 264.64  
ArcLength S,RK 101: 246.00  
ArcLength S,RK 1001: 244.13  
ArcLength S,RK 10001: 243.95

Taxiway Tool version 2.0 released 31 December 2008

System Map Target Help 0 Targets | Departures 0 (0kts) | Ar

Map: CLT

View

Type: NOT\_SET

Name:

| ATG Coordinate |                      | Degs Mins Secs |  |  |
|----------------|----------------------|----------------|--|--|
| X: 0.00        | Longitude: 0 0 0.000 |                |  |  |
| Y: 0.00        | Latitude: 0 0 0.000  |                |  |  |

On taxiways:

ment Info For: None

Segment View

Start Point:  
End Point:  
Initial Heading:  
Final Heading:  
Control 1 distance:  
Control 2 distance:  
Max Curvature:  
Avg Curvature:  
ArcLength S,RK 11:  
ArcLength S,RK 101:  
ArcLength S,RK 1001:  
ArcLength S,RK 10001:



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# Questions?