MACS Flight Deck Overview

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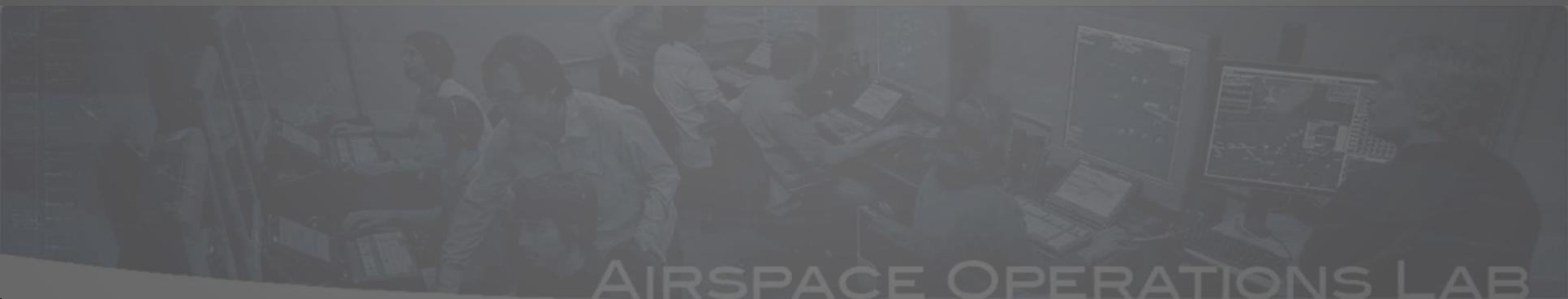
Outline

- Overview
- MACS Flight Deck Simulation Basics
- Flight Deck Capabilities
- Human-Automation Cooperation
- Other Flight Deck Options
- Pilot Workstation Configuration
- Troubleshooting

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MACS Flight Deck Overview

- MACS is a complete flight simulator
    - Originally started as an interface to PAS…
    - No "background" aircraft
        - All aircraft in MACS can be controlled by a human operators at any time
    - Can be configured as a pseudo pilot workstation designed around simulating/flying several aircraft
    - Can be configured as a single pilot workstation designed to better mimic the look and feel of a glass cockpit

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MACS Flight Deck Simulation Basics

Simulation Control
Aircraft Initialization
Aircraft Simulation
User Interface

Simulation Manager

ADRS

External Components

Aircraft Simulation
User Interface

Multi Pilot 1 **Multi Pilot 2** **Single Pilot 1**
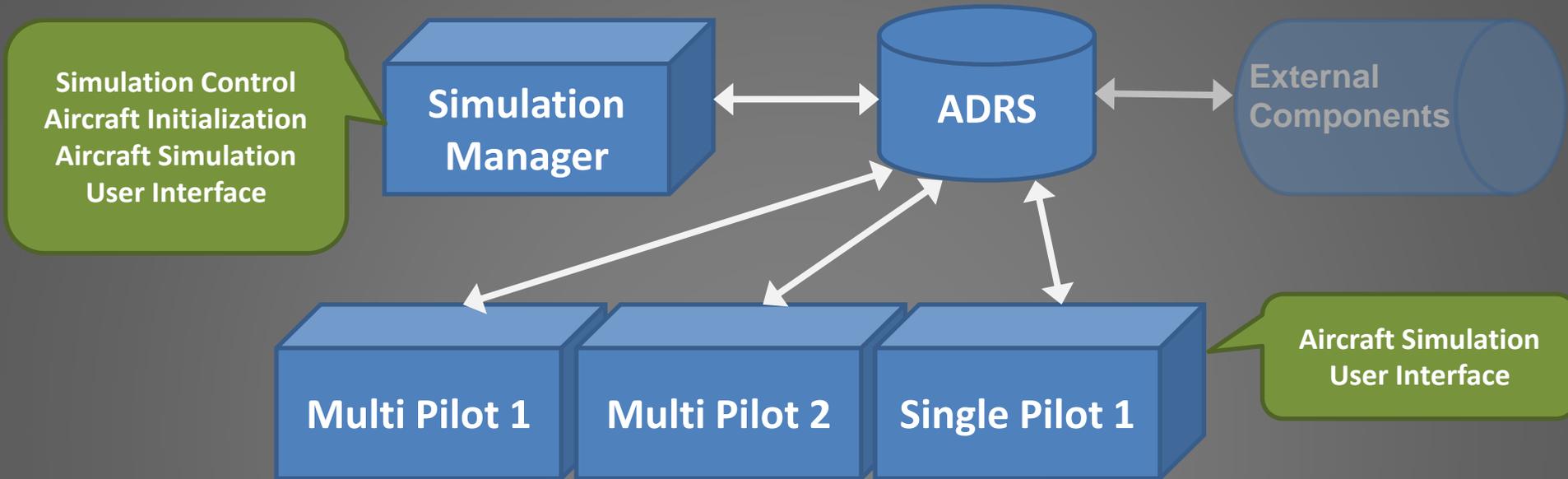
- MACS architecture
  - Each MACS pilot station simulates the aircraft directly
  - The simulation "moves" with the control from pilot station to pilot station

MACS Flight Deck Simulation Basics

- Aircraft modeling parameters specified in the traffic scenario file:
  - aeroModel
    - Simple, 4DOF
  - Weight
  - costIndex
- FMS navigation (nav) database comes from adaptation files
  - Airports, jet routes, airways, waypoints, SID/STAR/approach procedures*

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MACS Flight Deck Capabilities

- All MACS aircraft are FMS equipped
- Additional flight deck equipment can be enabled through the traffic scenario file
  - ADS-B equipage
  - CPDLC equipage
  - RTA equipage
  - ASAS equipage
- Wind information
  - Constant winds at altitude
  - Rapid Update Cycle (RUC) wind files
  - Can be different from actual winds and ATC winds

MACS Flight Deck Capabilities

- Path/Terminators
  - MACS uses Track to a Fix (TF) leg segment types
- Fixes
  - MACS uses Fly-by Fixes
- Crossing Restrictions
  - MACS uses only AT restrictions
- Holding functions
- Onboard Conflict Detection
- Data Comm
  - FANS-like CPDLC interface
  - Uplink and Downlink
- Integration with Cockpit Display of Traffic Information (CDTI)

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Human-Automation Cooperation

- MACS includes agent/automation support options to help with the pseudo pilot task
  - Prompts to alert the pseudo pilot of needed action
  - Location: Windows -> Setup Panels -> Event Control
  - Automated modes that can take ownership of certain tasks
    - Auto Speed Brakes
    - Auto Landing Gear
    - Auto Flaps
    - Auto Execute Route Mods
    - Auto Altitude Control
    - Auto Processing

Radio Check In	◄HI
Radio Request for Lower	◄FL?
Lower Mcp Altitude	MCP
End of Route	END
Free Flight/ATC Transition	FF/ATC
Entering Controlled Airspace	->CTRL
Heading Probes	|>HDG<|
Altitude Probes	|>ALT<|
Speed Probes	|>SPD<|
EDA Turn Back	TURN
EDA Descent Location	DES
Frequency Change	FREQ
Datalink Message	~@
Potential Conflict	0/--:--
Update Rta	RTA
Approach	APP

Human-Automation Cooperation

- ## Auto Altitude Control
  - Automatically lowers or raises Mode Control Panel (MCP) altitude target values
    - Requires VNAV
    - Can create a need for good pseudo pilot training

- ## Auto Processing
  - Automatically processes Data Comm messages received on the flight deck
    - Most received uplinks can be processed automatically
    - Processing occurs within a user-definable delay range
    - Independent control for the various messages

Human-Automation Cooperation

Location: Windows -> Setup Panels -> Flight
Deck Setup -> CPDLC Uplink tab

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Other Flight Deck Options

Location: Windows -> Setup Panels -> Flight Deck Setup -> FMS/CDTI tab
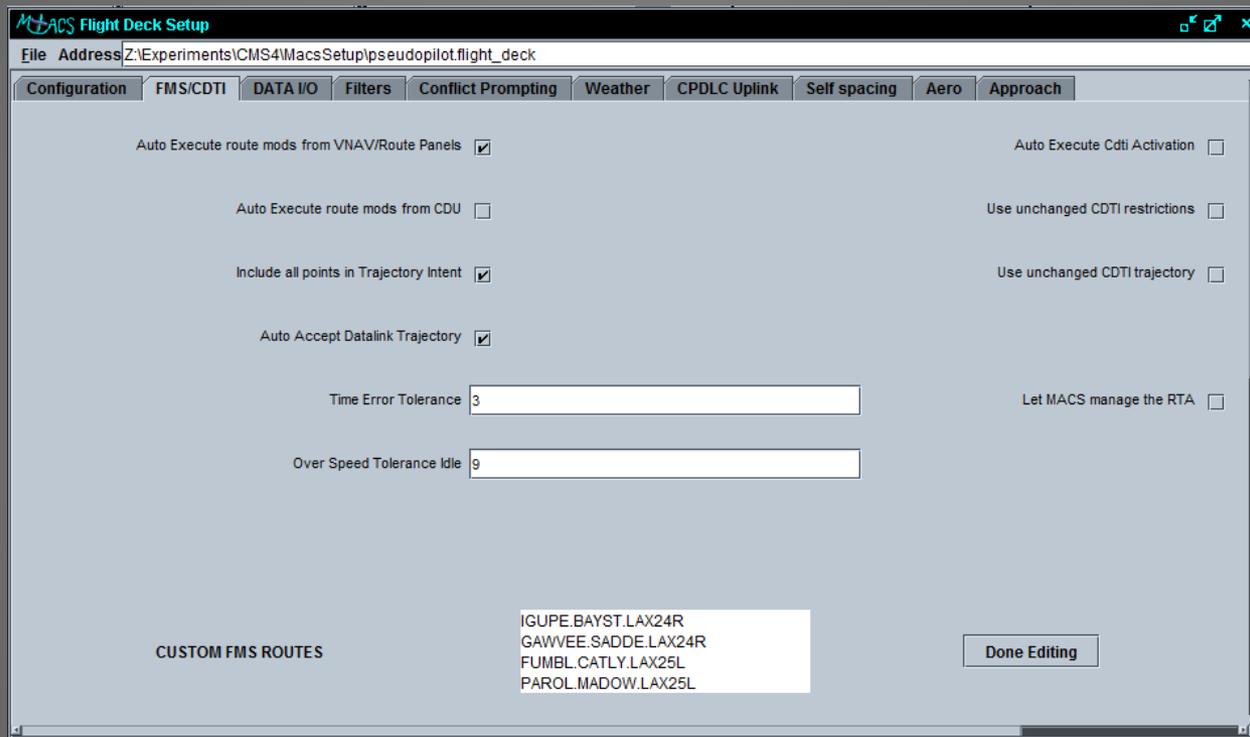
- Controls auto execute of route modifications
- Enter ATC procedure names to generate custom FMS routes

Other Flight Deck Options

-> Weather tab
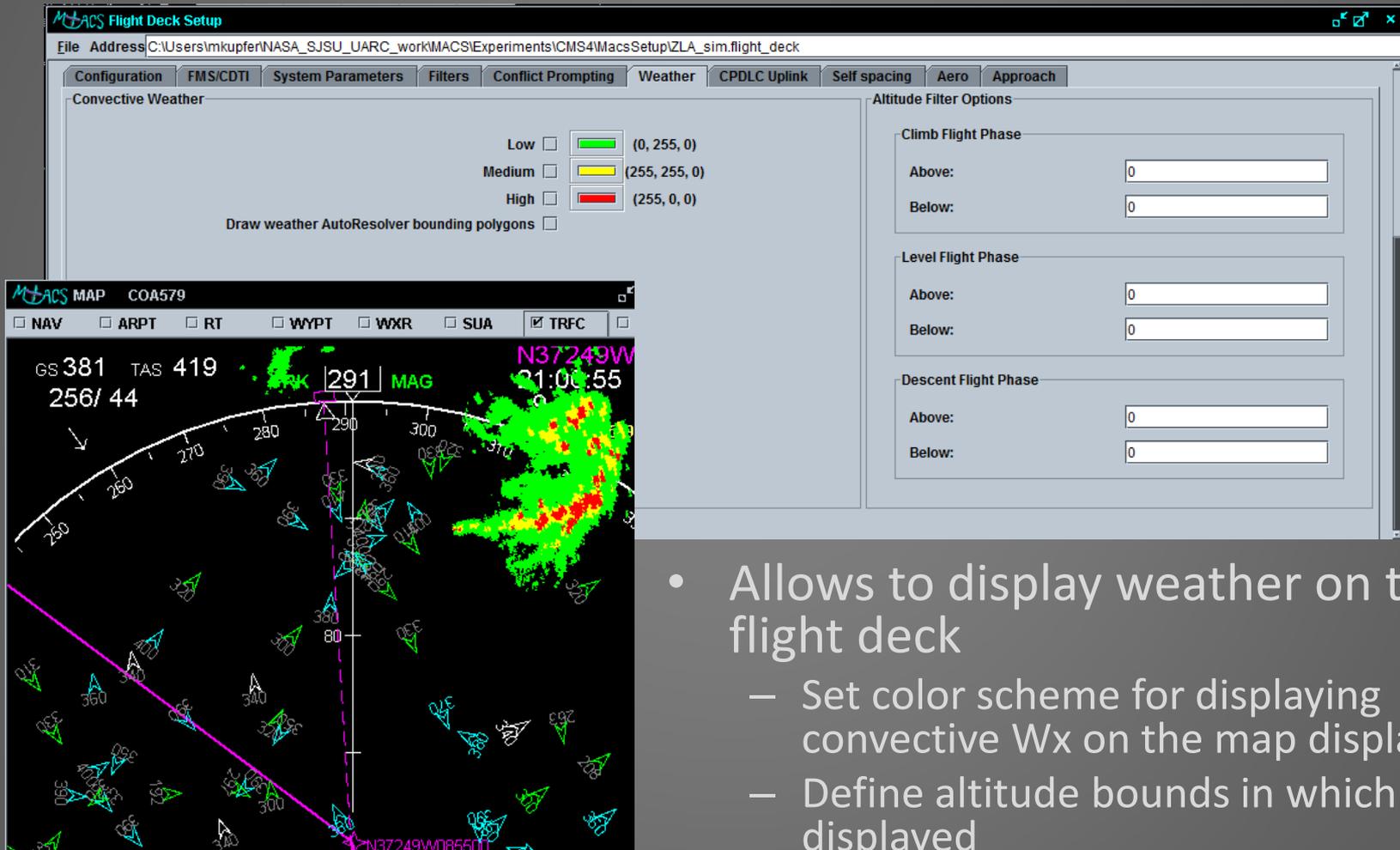
- Allows to display weather on the flight deck
  - Set color scheme for displaying convective Wx on the map display
  - Define altitude bounds in which Wx is displayed

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Pilot Workstation Configuration

- How are aircraft distributed across multiple pilot workstations?
  - A team effort
    - Sim manager
    - All other connected pilot workstations
    - If one crashes, the others can continue on
  - Critical piece of information: the control responsibilities (the "identity," or ownership rule) of each pilot workstation
    - Specified via pilot configuration files (*.cfg) in the MacsDatabase\config\ directory

```
NAME          zid_80


RULES         DISPLAY
sector        all
active        yes
playback      no
source        macs
flights       all
status        all
callsign      all
cdti          yes
END_RULES

RULES         CONTROL
sector        ZID_80
active        yes
playback      no
source        pas
source        macs
flights       all
status        all
callsign      all
cdti          yes
END_RULES

# SECTION 3:
RULES         EXCEPTION
END_RULES
```

Pilot Workstation Configuration

- How are aircraft distributed across multiple pilot workstations?
  - Important configs:
    - Plan_b (the simulation manager)
      - Owns all aircraft not owned by anyone else
    - View
      - Does not own any aircraft until manually attaches to a single aircraft
    - [name]
      - Usually a sector# or a combination of multiple sectors
      - Sector number specified is known internally to MACS as the AC sector number
        - » Specified at sim start in the traffic scenario file, and continuously updated as aircraft transit the airspace
      - Can also be defined by flight rules (free flight) or individual call sign

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Pilot Workstation Configuration

- How are aircraft distributed across multiple pilot workstations?
  - At sim start:
    - Simulation manager reads traffic scenario file and initializes trajectories of all aircraft (target generation)
    - ADRS looks for connected pilot workstations, and distributes aircraft matching the "identity" (ownership rules) of any connected pilot workstation
      - An attempt by a view pilot workstation to attach to an aircraft takes that aircraft from the sim manager
    - This action transfers the full task of simulating the aircraft to the respective pilot workstation

Pilot Workstation Configuration

- How are aircraft distributed across multiple pilot workstations?
  - ATC clearance: "SWA113 contact center at 121.82"
    - In MACS, sector frequencies are mapped to sector numbers
      - Sector_frequency_table (located in the airspace's custom\ directory)

```
#2011.02.02 - This file specifies available handoff defaults and frequencies
#
default 110.00
trashcan 120.00

ZID_80 120.62
ZID_81 121.82
```

  - "SWA113 switching to 121.82, good day"

MACS Pilot Handoff SWA113						
110.0	116.15	118.1	120.0	120.62	121.82	CONTROL

MACS Pilot Handoff SWA113						
110.0	116.15	118.1	120.0	120.62	121.82	STEAL
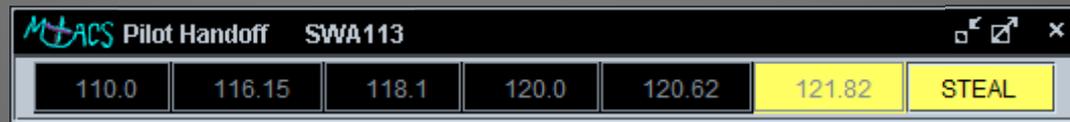
  - "Center, SWA113 checking in…"
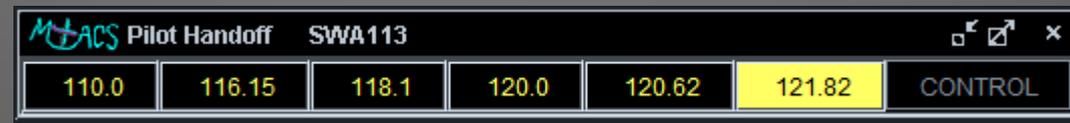
SWA113	B737 OVR
◀HI	

MACS Pilot Handoff SWA113						
110.0	116.15	118.1	120.0	120.62	121.82	CONTROL

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Troubleshooting

- "Where did I go wrong?"

- Aircraft doesn't land?
  - "Descent for landing" in FMS route panel checked?
  - In SPD SEL? Needs to be in VNAV speed.
  - Aircraft too fast?
  - In FLCH? Needs to be in VNAV.
  - Aircraft too high?
  - Database's runway altitude correct?

Troubleshooting

- Context = why aren't my aircraft climbing/descending?

- Auto altitude control

  – Open loop simulations

  – Scenario development

  – …
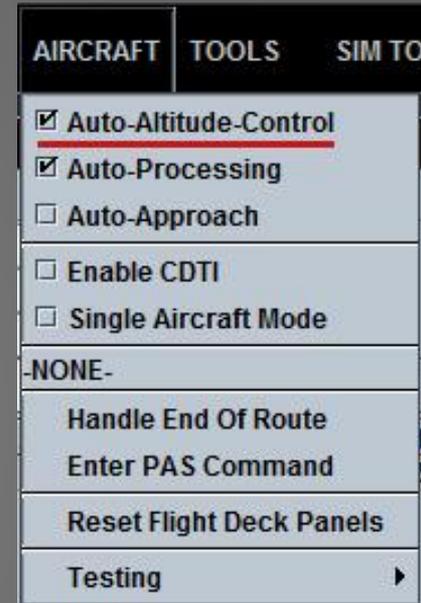
- Example: auto descent into TRACON

(FMS computes TOD, initialize descent once at this point)

  – Auto: check Auto-Altitude-Control in Aircraft menu

  – Alternatively, manual control: check precision Descent (and Descent via Transition and Descend for Landing) in the FMS Route Panel

Troubleshooting

- It appears that none of my pilot stations own aircraft234!
  - Multiple Simulation Manager (plan_b) stations
    - This can cause lots of other problems
  - Multiple instances of MACS running on the same machine
  - Verify the config files loaded by all your pilot stations

Troubleshooting

- The route loaded into my aircraft's FMS doesn't look right…
  - Verify the spelling and syntax of the route in your scenario file
  - Verify the fms_procedures file you're using is set up properly and includes the restrictions you want
  - Verify waypoints along a route are not too close together

Troubleshooting

- Help, my pseudo pilots are overloaded!
  - Use two people to staff busy pseudo pilot stations
    - E.g., lots of a/c, high frequency of clearances, vectoring in a voice environment
  - Suggested strategy: voice communication – computer interaction split

Troubleshooting

- Why does an aircraft shows up in my control list that shouldn't be here? It's flying in a completely different area than all the other planes I own…
  - Other pilot shipped it to the wrong frequency?
    - Happens in real world, too, let the controllers figure it out.
    - The pseudo pilot can also steal the aircraft

Questions?

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Aircraft Simulation and Flight Deck Displays

- Full flight Simulator

- Selectable Dynamics Model (Motion Predictor, 4DOF/PAS-Aero, …)

- Flight deck for external target generator

- Performance Models for the majority of current aircraft types

- Selectable Equipage

- Glass cockpit displays

- Full FMS capabilities with RTA (Also used in Standalone mode)

- ASAS spacing and merging logic

- Conflict detection logic for (airborne self-separation)

- FANS – style CPDLC interface

- Interface to advanced Cockpit Display of Traffic Information

- Automatic processing of selected data link messages with predefined delays

- Agent support for pseudo pilots (reminders or automation)

Troubleshooting

- Enter ATC route options (go-around)
  - Prepare flight deck to execute go-arounds by entering <u>go-around atc_procedure</u> names
  - Don't confuse with fms_procedures: MACS matches the waypoints of the respective go-around atc_procedure with the fms_procedures
  - Semicolon separated!

MACS Flight Deck Simulation Basics

- Aircraft lists
  - ALL
  - ACTIVE
  - INACTIVE
  - CTRL
  - VIEW
  - TODO
  - DONE
- How fms_procedures file works...