Tuesday (01/10/2012)
Briefings

08:30	Intro and MACS Overview
09:40	Break
10:00	MACS/ADRS simulation architecture and integration with ATOS and TMA
11:00	Using MACS to simulate aircraft operations *Simulation Manager and Flight Deck Stations*
12:00	Lunch
1:00	Basic Air Traffic Control Operations.
1:30	Using MACS to simulate near-term air traffic control operations. *Focus ATD-1, Center/TRACON workstations, Scheduling, CMS*
2:45	Break
3:00	Using MACS to simulate far-term automated air traffic control operations. *Focus on Separation Assurance*
3:45	Developing MACS Software
4:30	End of day

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Using MACS to simulate aircraft operations Simulation Manager and Flight Deck Stations
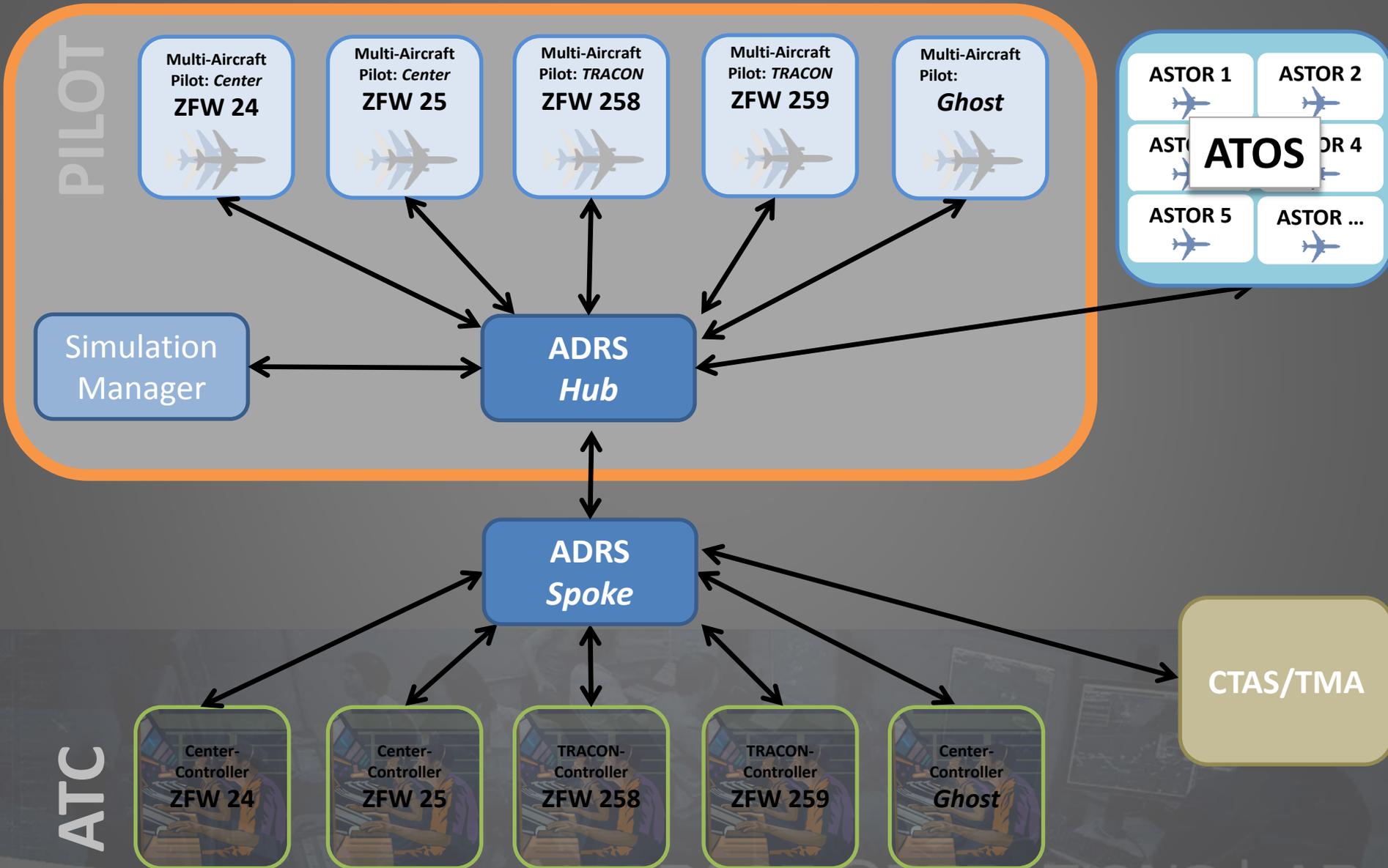
MACS Flight Deck Overview

Joey Mercer & Michael Kupfer

AIRSPACE OPERATIONS LAB

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

MACS Flight Deck Overview

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- Overview

- **MACS Flight Deck Simulation Basics**

- Flight Deck Capabilities

- Human-Automation Cooperation

- Other Flight Deck Operation

- Pilot Workstation Configuration

- Troubleshooting

MACS Flight Deck Simulation Basics

Simulation Control
Target Generation
Aircraft Dynamics
User Interface

Simulation Manager

ADRS

External Components

Multi Pilot 1

Multi Pilot 2

Single Pilot 1

Target Generation
Aircraft Dynamics
User Interface

- 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*
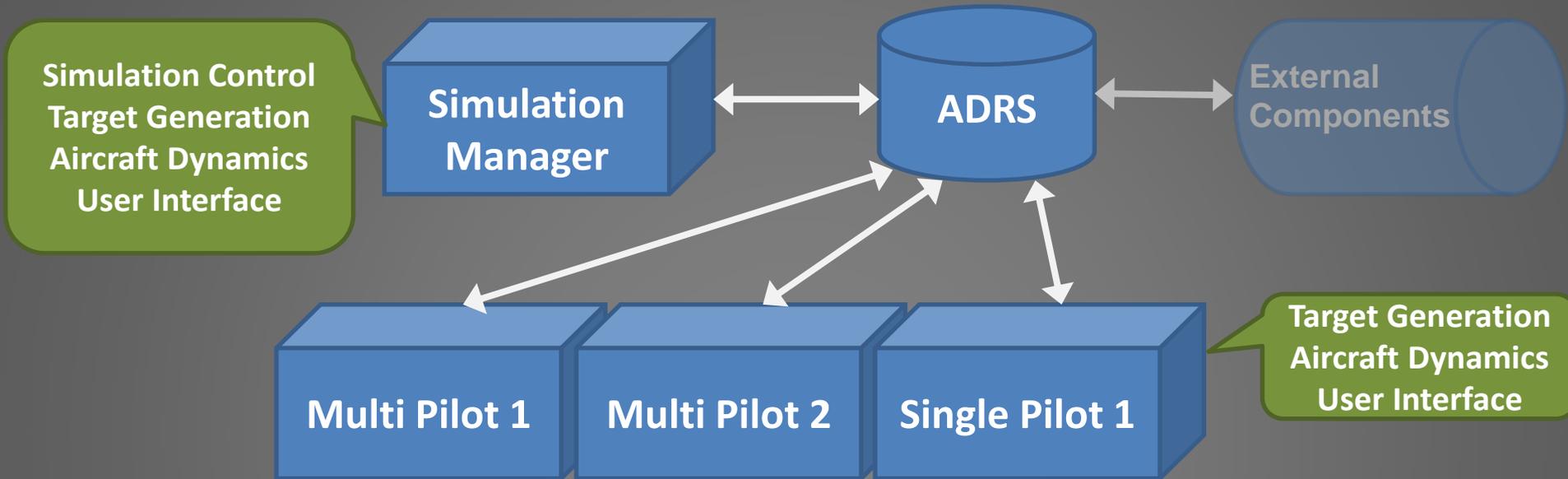
Outline

- Overview

- MACS Flight Deck Simulation Basics

- **Flight Deck Capabilities**

- Human-Automation Cooperation

- Other Flight Deck

- Pilot Workstation Configuration

- Troubleshooting

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

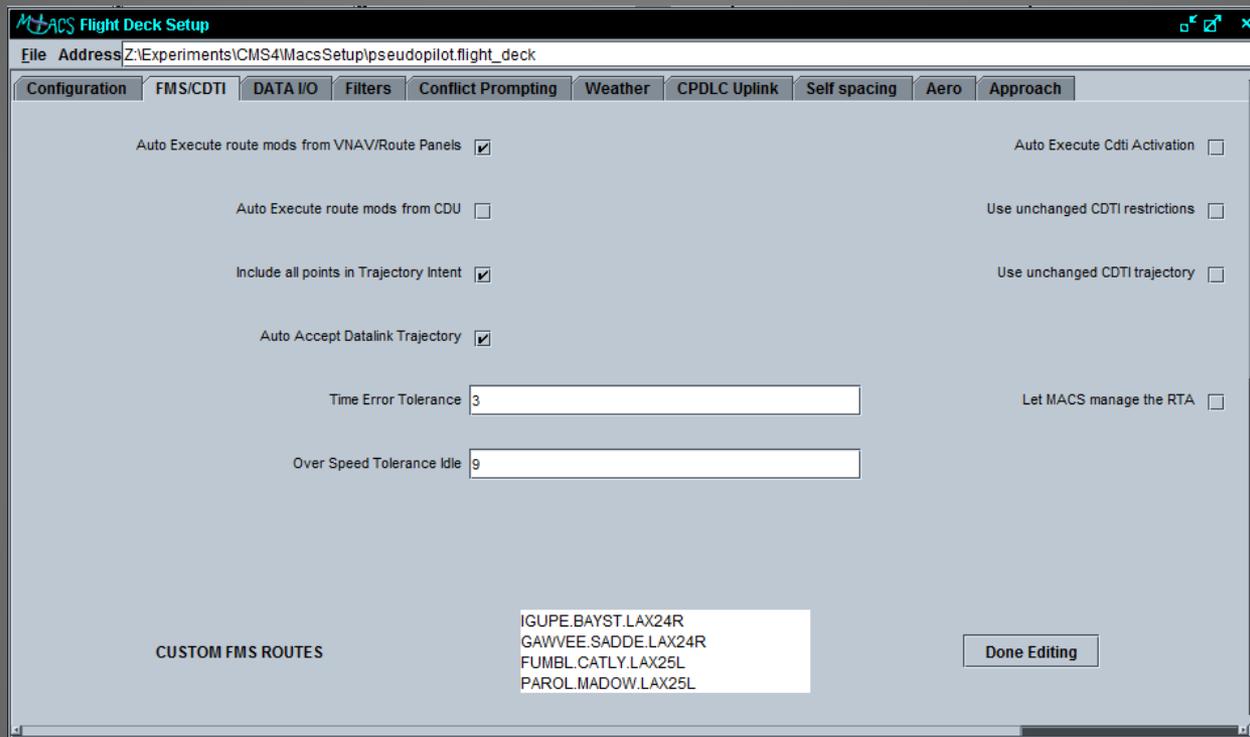Location: Windows -> Setup Panels -> Flight
Deck Setup -> CPDLC Uplink tab

Auto Execute RTA msgs ☑	RTA Time Delay (secs) Min 8	Max 10
Auto Execute Frequency Change msgs ☑	Frequency Change Time Delay (secs) Min 5	Max 6
Auto Execute Speed msgs ☑	Speed Time Delay (secs) Min 5	Max 6
Auto Execute Altitude msgs ☑	Altitude Time Delay (secs) Min 5	Max 6
Auto Execute Route Modification msgs ☑	Route Time Delay (secs) Min 5	Max 6
Auto Execute Self-Spacing msgs ☑	Self-Spacing Time Delay (secs) Min 8	Max 10
Auto Execute Flight Rule (AFR/MFR/IFR/VFR) msgs ☑	Flight Rule Time Delay (secs) Min 5	Max 6
Auto Speak Audo Text Message ☑ Auto Execute Audio Text Command ☑	Audio text Time Delay (secs) Min 2	Max 4
Auto exec no older than (sec) 120		

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- **Other Flight Deck Options**

- Pilot Workstation Configuration

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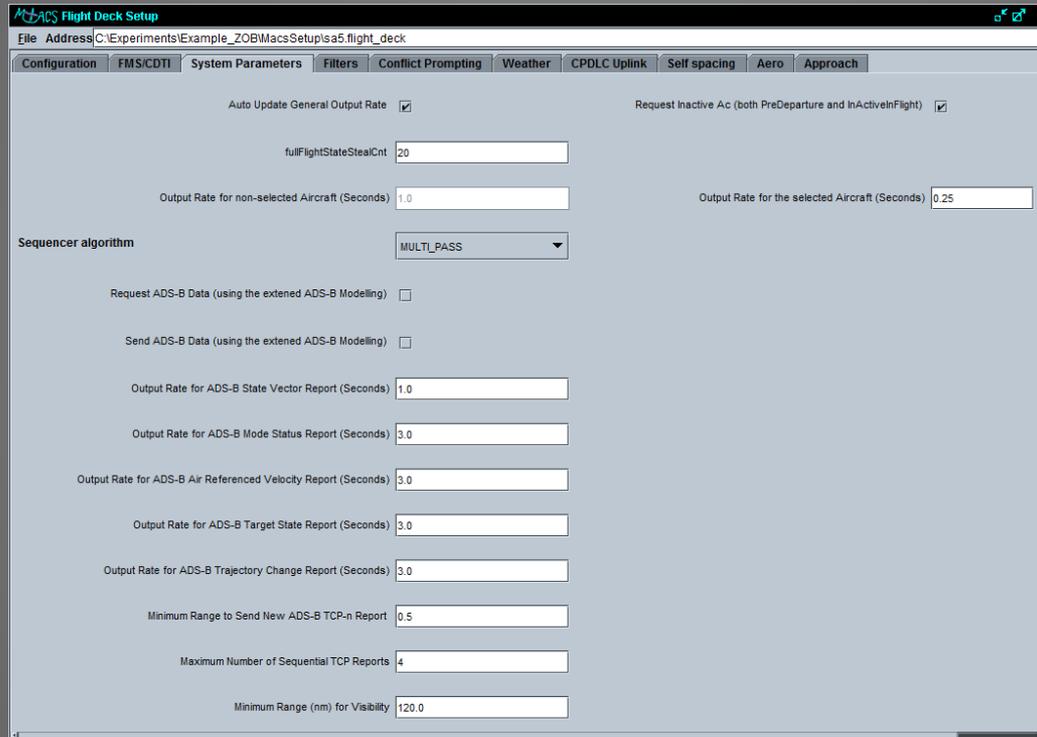
Other Flight Deck Options

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
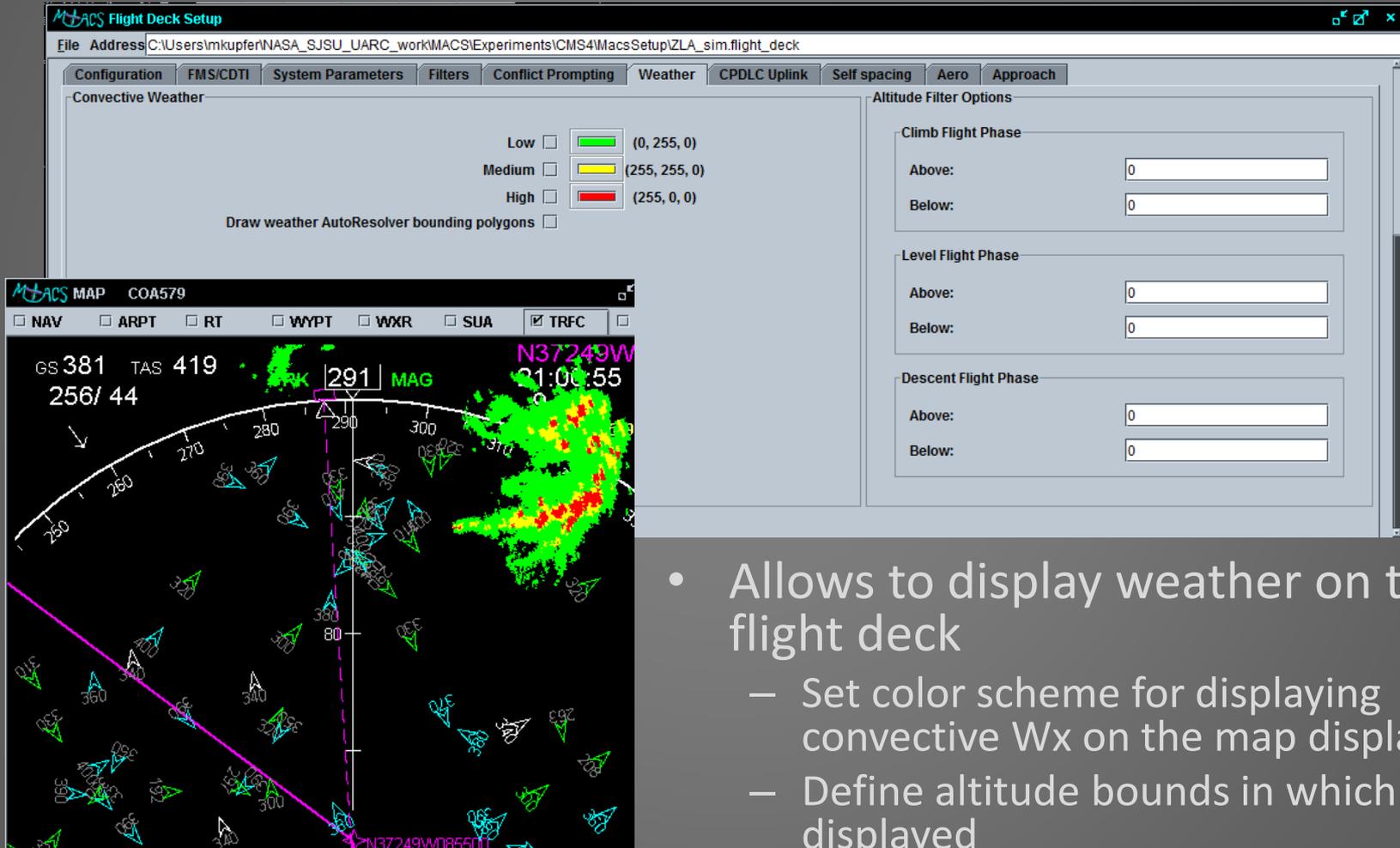
Other Flight Deck Options

Location: Windows -> Setup Panels -> Flight Deck Setup
-> System Parameters tab

- Includes options for the flight deck sequencing logic and the ADS-B messaging capabilities

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**

- Troubleshooting

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

```
NAME            zid_80


RULES           DISPLAY
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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 flight plan, flight state, trajectories and guidance information for all aircraft
    - 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, which generates flight state, trajectories and guidance information for the aircraft until handed off to the next station

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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

- Why aren't my aircraft climbing/descending?
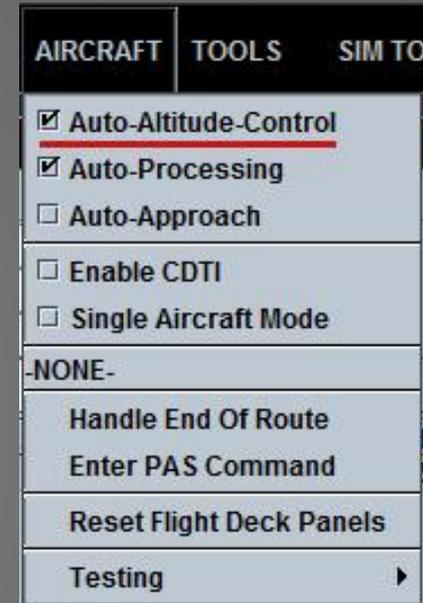 - Auto altitude control
    - Open loop simulations
    - Scenario development
    - …

- 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 Descend 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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- Joey Mercer – joey.mercer@nasa.gov, (650)-604-0017
- Michael Kupfer - michael.kupfer@nasa.gov, (650)-604-4624

Pilot Workstation Configuration

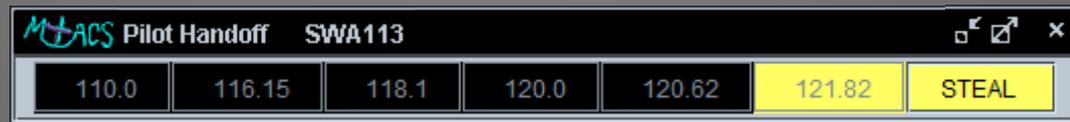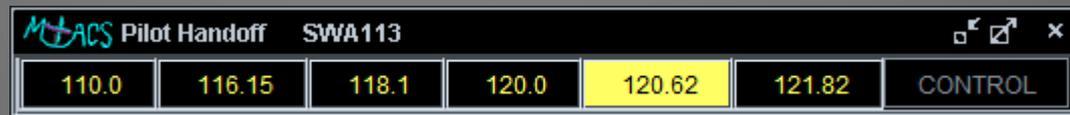- How are aircraft distributed across multiple pilot workstations?
  - ATC clearance: "SWA113 contact center at 121.82"
    - In MACS, sector frequencies are mapped to sector numbers
      - Sector_frequency_table (located in the airspace's custom\ directory)

```
#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