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

ATD-1 Technical Objective

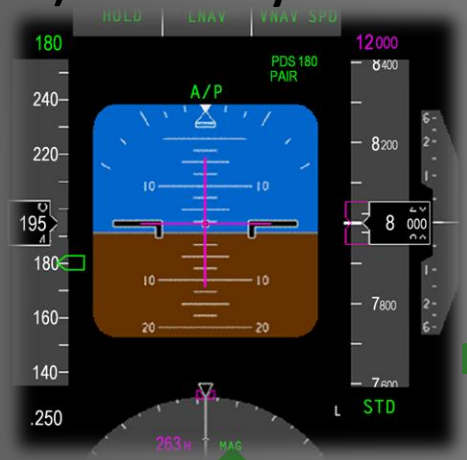
Demonstrate feasibility of sustained high throughput of fuel-efficient arrival operations using precision time-based scheduling, speed control and CNS technologies

Advanced Traffic Management Advisor (TMA)
Controller-Managed Spacing (CMS) Tools
Flight Deck Interval Management (FIM)
ADS-B Infrastructure
Area Navigation (RNAV) Arrival Routes
Optimized Profile Descent (OPD) Procedures

ATD-1 Technologies

Integrated Arrival Solution

Flight Deck Interval Management (FIM) to Runway Threshold

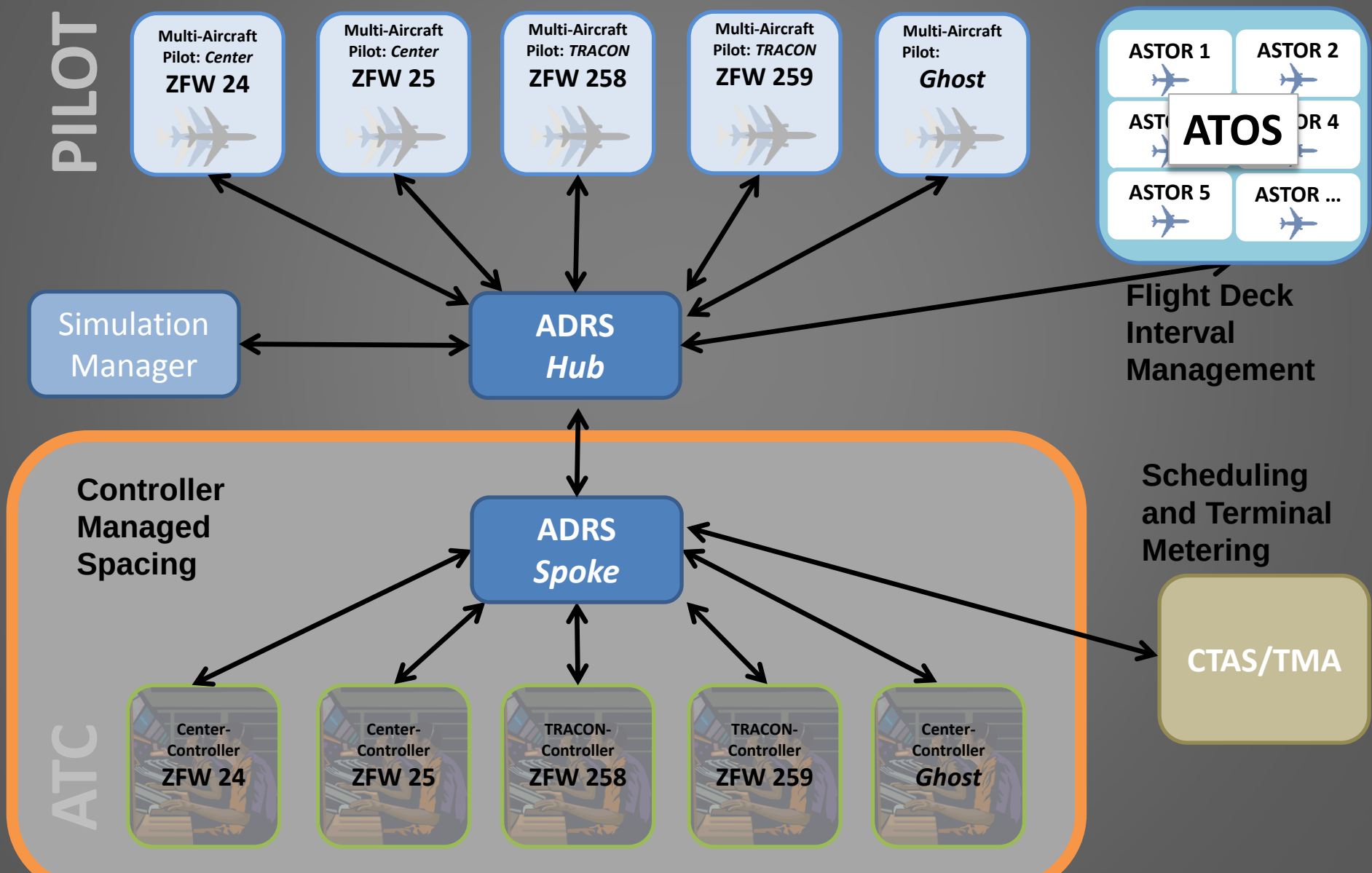


ADS-B infrastructure

Controller Managed Spacing (CMS) in Terminal Airspace

Advanced Traffic Management Advisor (TMA) with Terminal Metering

ATD 1 components. CMS on MACS ATC workstations. Scheduling and Terminal Metering with TMA. Flight Deck Interval Management with ATOS, ASTOR, ASTAR



Initial ATD-1 Simulation in Airspace Operations Laboratory at NASA Ames

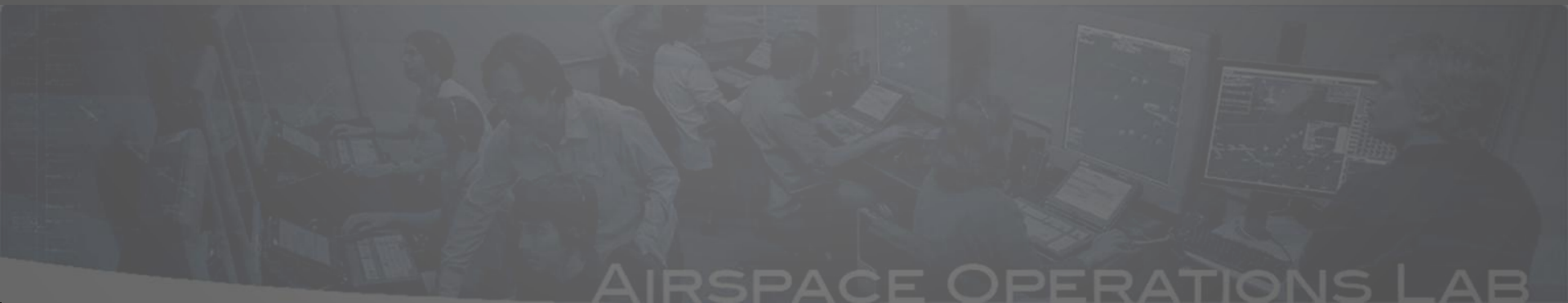
- Controller Managed Spacing/ATD1 (CA1)
- Focus on operational procedures and controller tools with mixed equipage (some aircraft conduct flight deck-based interval management, some don't)
- Situated in Dallas/Ft. Worth (to leverage LaRC-developed IM routes for DFW)

- Integration simulation in December 2011
  - Integration exercise: Data flows, connectivity, proper functioning of all systems, initial experience with technologies and operational procedures

- Data collection in January 2012
  - Controlled experiment: Refined operational procedures, controller tools

Simulating Near Term Operations using MACS Controller Managed Spacing/ATD1 (CA1) Simulation

Michael Kupfer

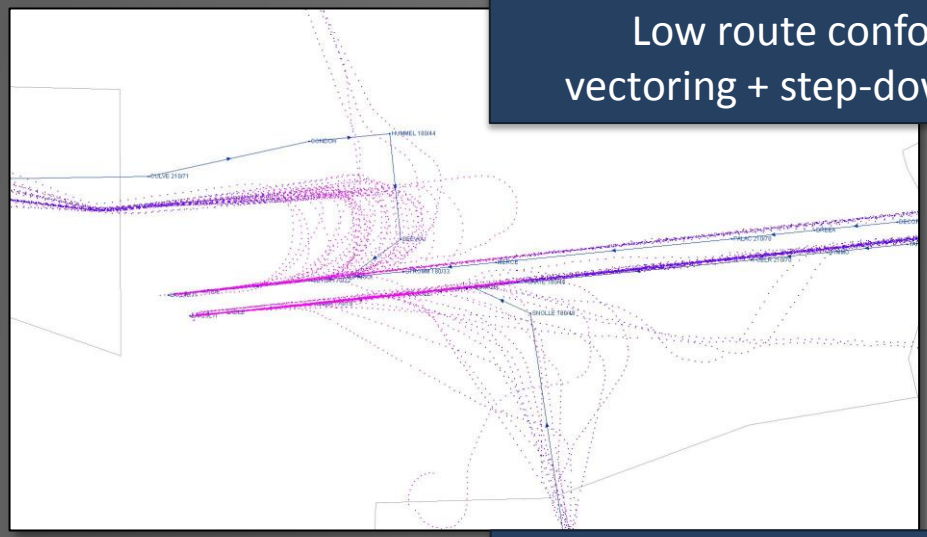


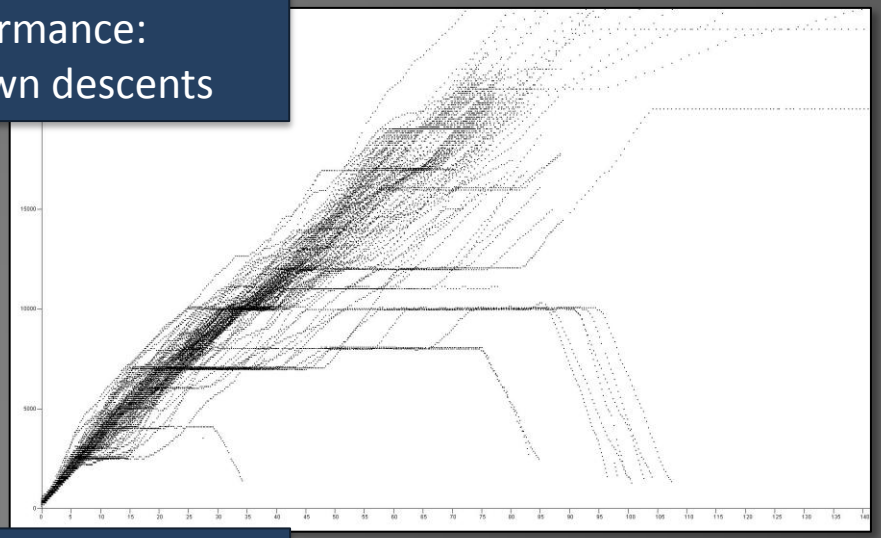
Outline

- Problem
- Objective
- Concept
- Approach
- CMS Tools
- Airspace and Routes
- MACS Operator Modes
- MACS Controller and Pilot Stations
- Controller Tasks
- Handoffs in MACS
- Q&A

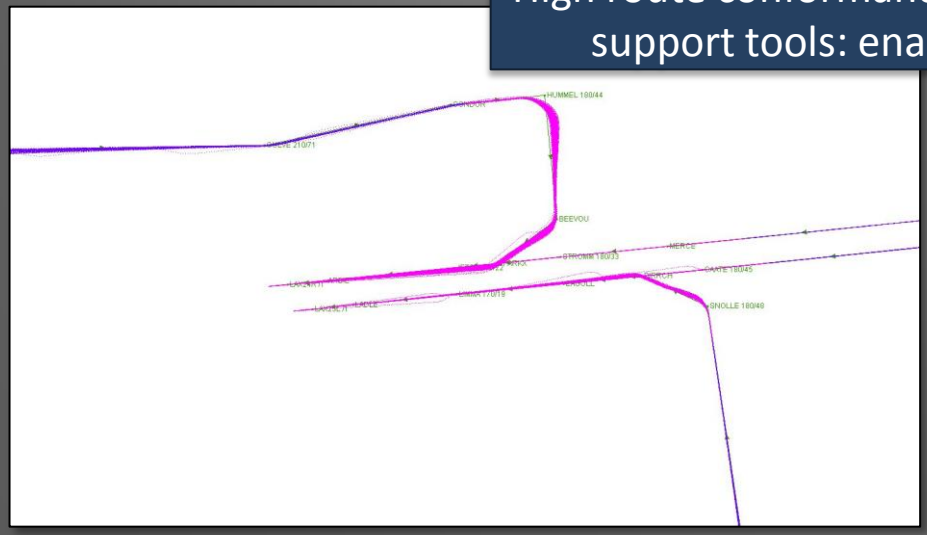
The Problem

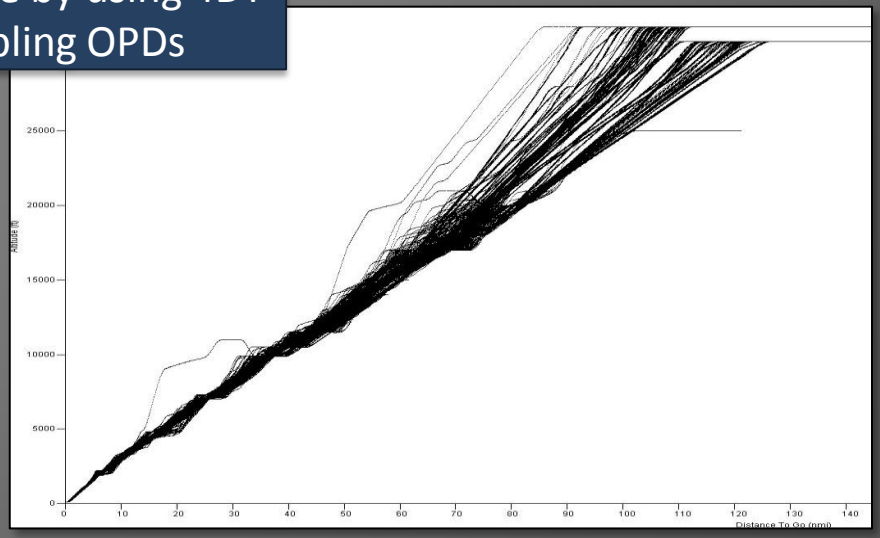
Low route conformance:
vectoring + step-down descents





High route conformance by using 4DT support tools: enabling OPDs

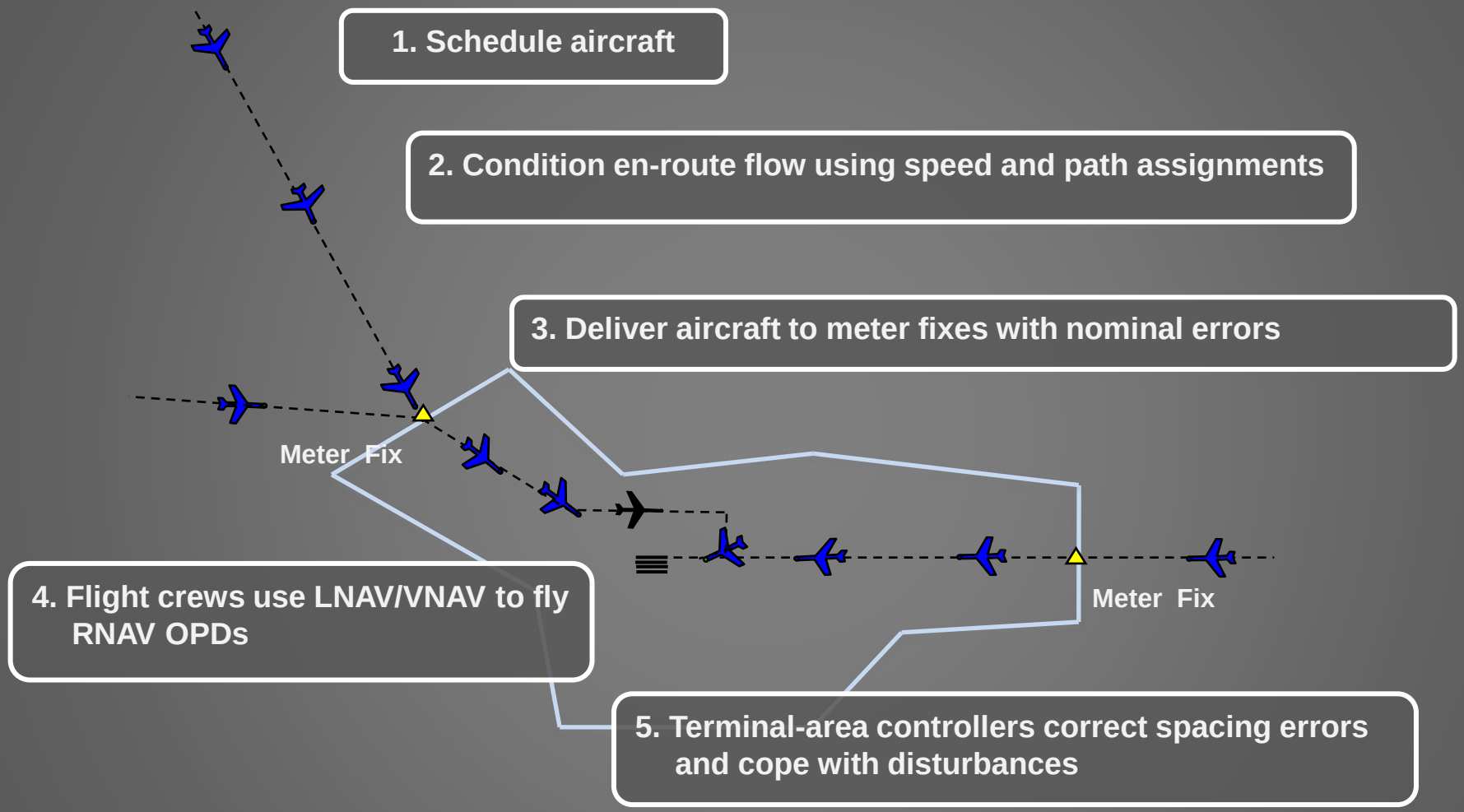




CA-1 Objective

- Evaluate and refine controller tools, procedures, and phraseology for schedule-based RNAV OPD arrival operations when arrival flows include a mix of CMS and FIM aircraft
  - Ground-side focus
  - Nominal operations
  - Advanced Traffic Management Advisor (TMA)
  - Controller-Managed Spacing (CMS) Tools
  - Flight Deck Interval Management (IM)
  - ADS-B Infrastructure
  - Area Navigation (RNAV) Arrival Routes
  - Optimized Profile Descent (OPD) Procedures

Schedule-Based Arrival Management Concept



Safe, quiet, fuel-efficient, and robust Optimized Profile Descent (OPD) operations with sustained high throughput

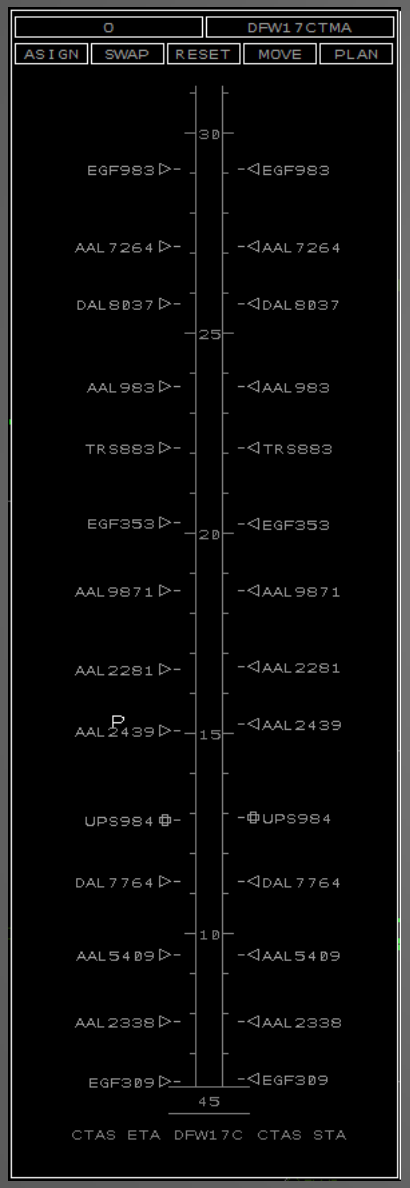
Approach

- What controller tools, procedures, and phraseology should be provided to controllers to ensure safe, efficient, schedule-based RNAV OPD arrival operations when the traffic includes a mix of CMS and FIM aircraft?

- DFW Airspace with routes to runway 17C
- MACS controller tools
- Schedules provided by Advanced TMA
- ASTOR FIM-equipped simulators
- Initial focus:
  - Laboratory integration
  - Training
  - Data collection/analysis harmonization

Controller Managed Spacing Tools

Timeline



ETA ***STA***

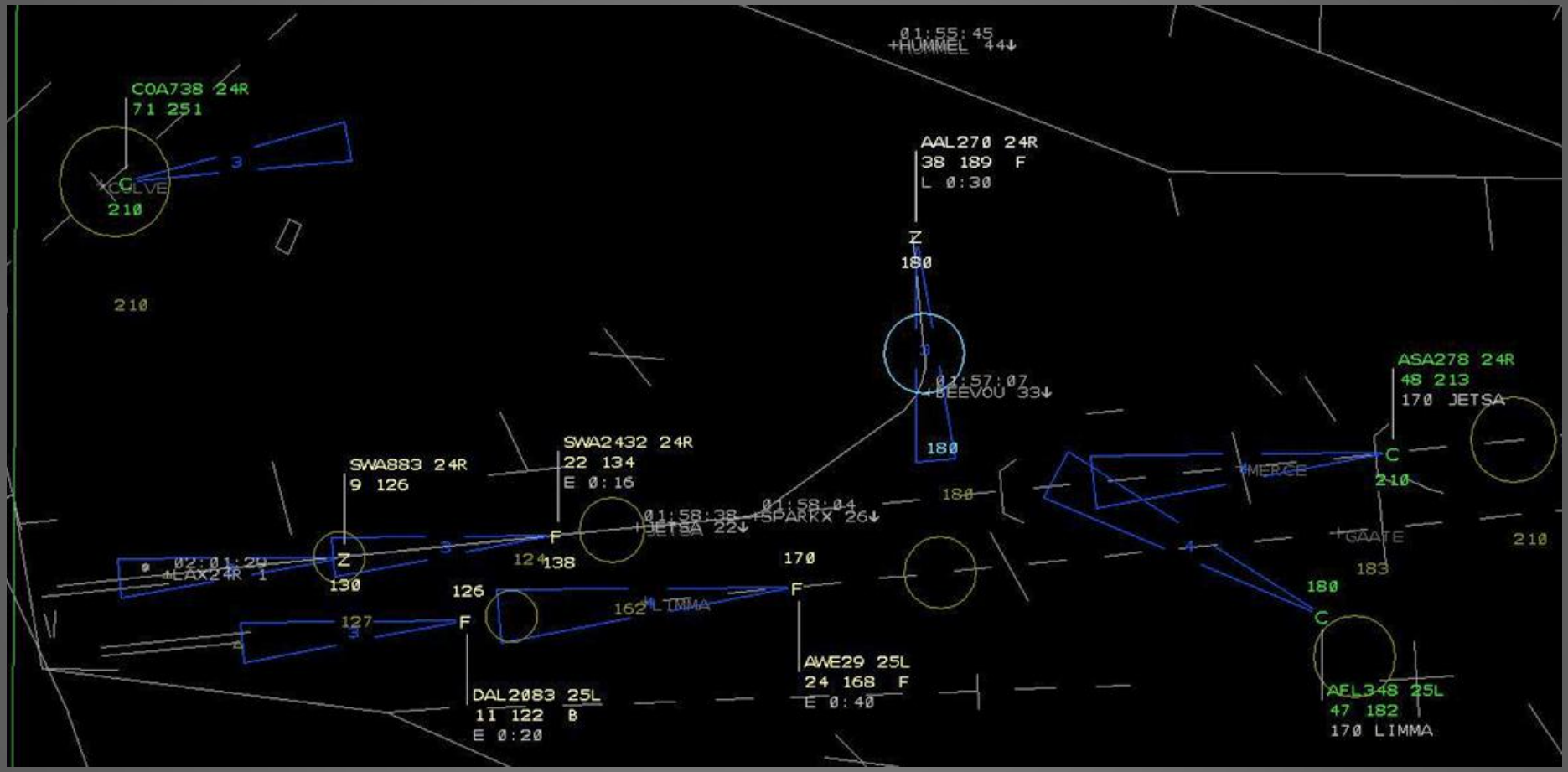
Slot Marker

Early/Late indication

Speed Advisory

CMS tools use nominal arrival procedures. In MACS they are defined in the atc_prcedure file

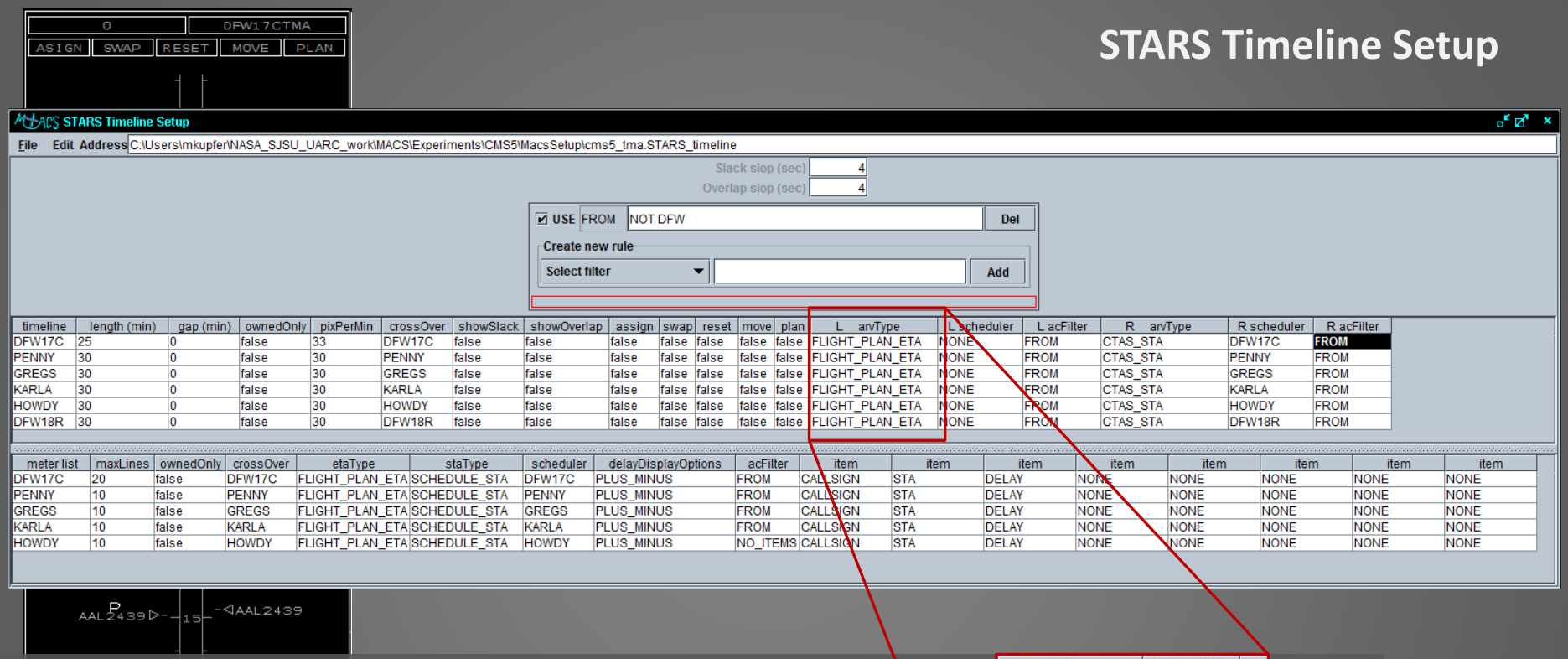
Display Example with Tool Descriptions



- Slot markers show each aircraft's predicted location were it to fly the nominal profile through the *forecast* wind field and arrive on schedule (dwelling on an aircraft highlights its slot marker)
- Display shows airspeed of both slot marker and target aircraft
- Speed advisories show a *speed* to fly until resuming the nominal profile speeds at a *waypoint* (if no such advisory can be found, the early/late indication is displayed)
- Cones ('bats') may be toggled for all aircraft or specified aircraft

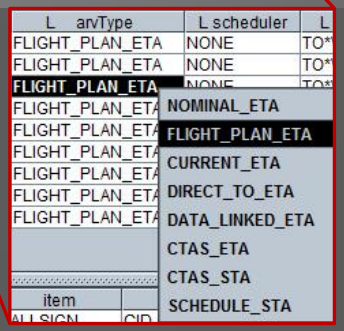
CMS tool setup in MACS setup files

STARS Timeline Setup



timeline	length (min)	gap (min)	ownedOnly	pixPerMin	crossOver	showSlack	showOverlap	assign	swap	reset	move	plan	L arvType	L scheduler	L acFilter	R arvType	R scheduler	R acFilter
DFW17C	25	0	false	33	DFW17C	false	false	false	false	false	false	false	FLIGHT_PLAN_ETA	NONE	FROM	CTAS_STA	DFW17C	FROM
PENNY	30	0	false	30	PENNY	false	false	false	false	false	false	false	FLIGHT_PLAN_ETA	NONE	FROM	CTAS_STA	PENNY	FROM
GREGS	30	0	false	30	GREGS	false	false	false	false	false	false	false	FLIGHT_PLAN_ETA	NONE	FROM	CTAS_STA	GREGS	FROM
KARLA	30	0	false	30	KARLA	false	false	false	false	false	false	false	FLIGHT_PLAN_ETA	NONE	FROM	CTAS_STA	KARLA	FROM
HOWDY	30	0	false	30	HOWDY	false	false	false	false	false	false	false	FLIGHT_PLAN_ETA	NONE	FROM	CTAS_STA	HOWDY	FROM
DFW18R	30	0	false	30	DFW18R	false	false	false	false	false	false	false	FLIGHT_PLAN_ETA	NONE	FROM	CTAS_STA	DFW18R	FROM

meter list	maxLines	ownedOnly	crossOver	etaType	staType	scheduler	delayDisplayOptions	acFilter	item	item	item	item	item	item	item	item
DFW17C	20	false	DFW17C	FLIGHT_PLAN_ETA	SCHEDULE_STA	DFW17C	PLUS_MINUS	FROM	CALLSIGN	STA	DELAY	NONE	NONE	NONE	NONE	NONE
PENNY	10	false	PENNY	FLIGHT_PLAN_ETA	SCHEDULE_STA	PENNY	PLUS_MINUS	FROM	CALLSIGN	STA	DELAY	NONE	NONE	NONE	NONE	NONE
GREGS	10	false	GREGS	FLIGHT_PLAN_ETA	SCHEDULE_STA	GREGS	PLUS_MINUS	FROM	CALLSIGN	STA	DELAY	NONE	NONE	NONE	NONE	NONE
KARLA	10	false	KARLA	FLIGHT_PLAN_ETA	SCHEDULE_STA	KARLA	PLUS_MINUS	FROM	CALLSIGN	STA	DELAY	NONE	NONE	NONE	NONE	NONE
HOWDY	10	false	HOWDY	FLIGHT_PLAN_ETA	SCHEDULE_STA	HOWDY	PLUS_MINUS	NO_ITEMS	CALLSIGN	STA	DELAY	NONE	NONE	NONE	NONE	NONE



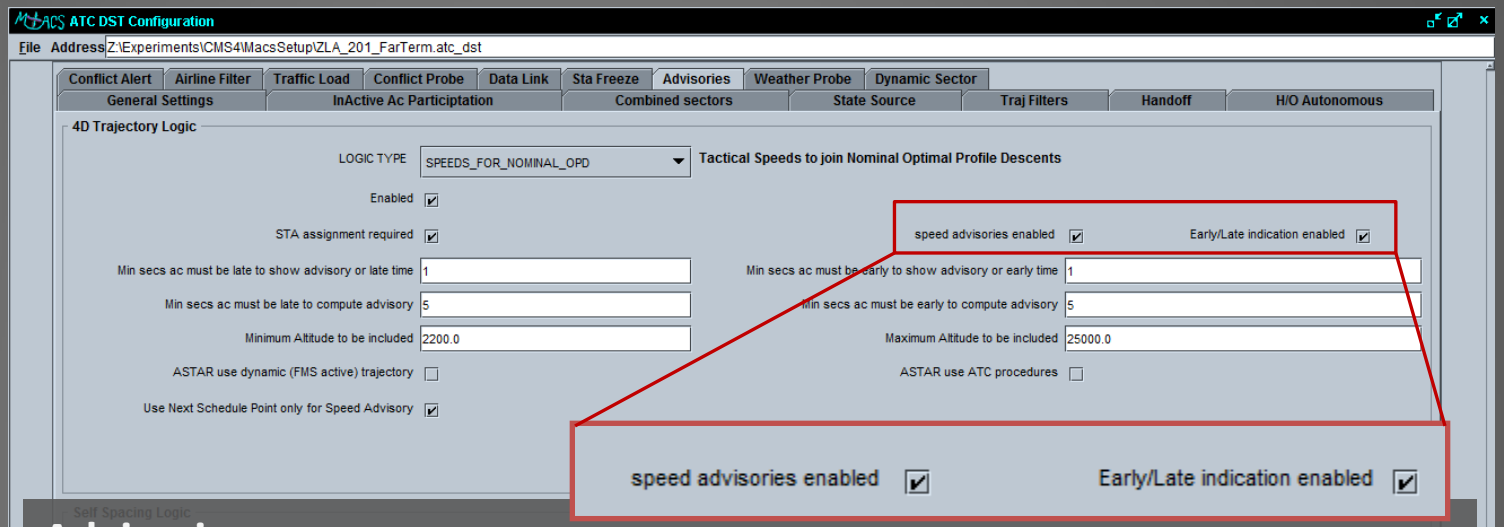
- Define timelines and meter lists
  - ETA/STA types
  - Appearance
  - Filters
- Requires the setup of the Scheduler Setup
- Feeds into STARS Sector PlanView Setup → Optional Views

CMS tool setup in MACS setup files

Early/Late Indicator

Speed Advisory

ATC DST Configuration



Advisories

- Enable/disable Speed Advisories, Early/Late indicators, Self Spacing
- Different Logic types and spacing protocols e.g.,
  - SPEEDS_FOR_NOMINAL_OPD
  - AIRBORNE_SPACING_ADVISORY
  - SPACING_FEEDBACK
- Set parameters for when advisories are displayed

CMS tool setup in MACS setup files

STARS Plan View Setup

Slot Marker

wSetup

ments\CMS4\MacsSetup\ZLA_201_FarTerm.STARS_planView

Mode Feedback | Sector Display | Mouse/Keyboard/DAK | ATC Specific Options | DataTag Popup Views | Ac to Display | Target/History | Tools | Weather

play

time

Entire plan

Show trajectory

symbol

Symbol: NONE

Symbol size: 6

pulse predictors

Show pulse predictor

Pulse symbol: NONE

Pulse symbol size: 6

Pulse time interval (secs): 30

Halos/Jrings

Show radius value when showing halo/jring

Spacing circles

Show spacing circles for all aircraft

Show spacing circles for dwelled aircraft

Cones

Base cone length on runway scheduler

Base cone length on next merge point scheduler

Base cone length on lead aircraft

Slot Markers

Show slot markers for all aircraft

Show slot markers for dwelled aircraft

Show slot markers for controlled aircraft

Show slot marker after handoff

Slot Markers

Show slot markers for all aircraft

Show slot markers for dwelled aircraft

Show slot markers for controlled aircraft

Show slot marker after handoff

Timeout after Handoff (sec): 10

Timeout for all Slots (sec): 10

Time Based Radius: 7.5

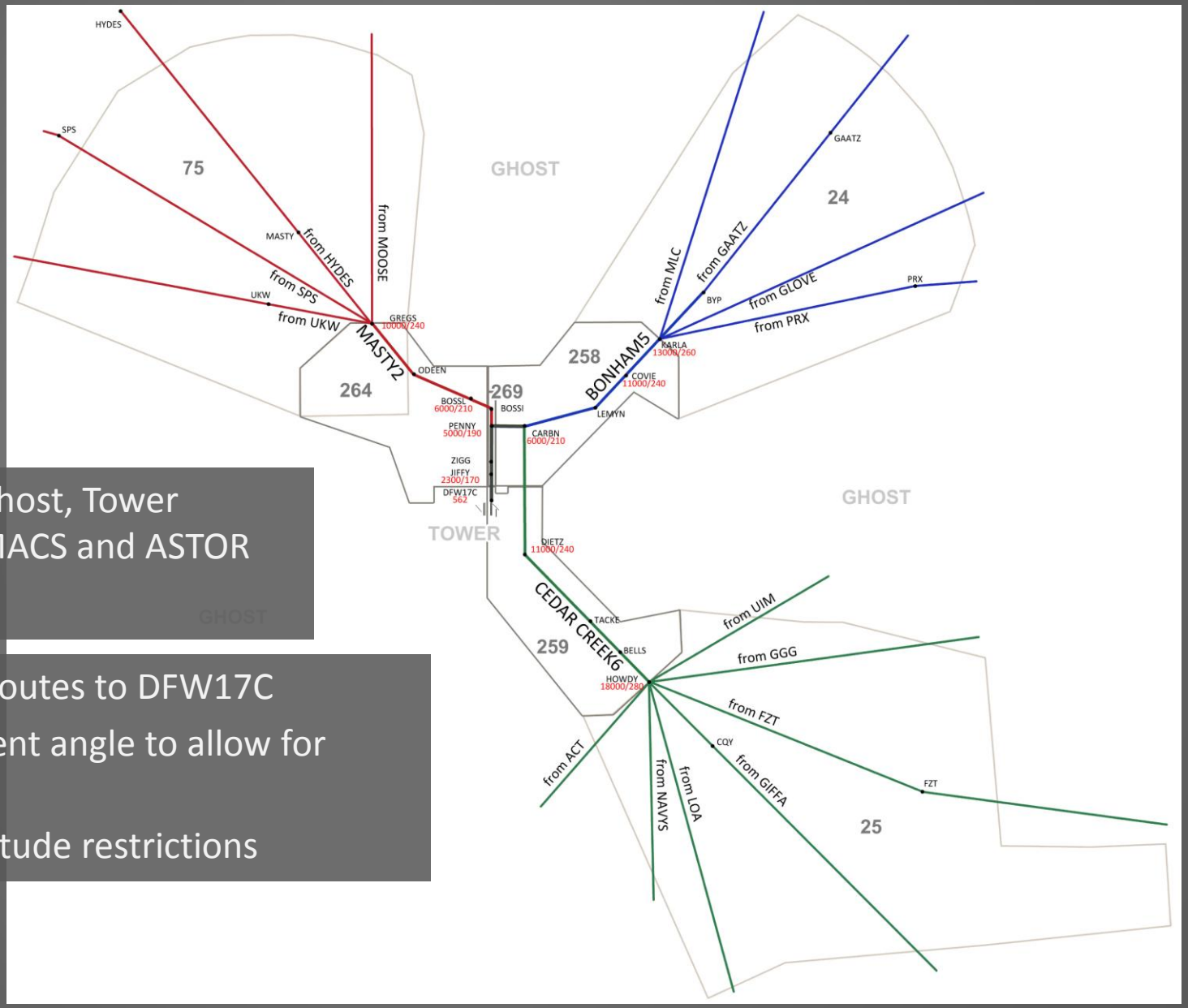
Show ground speed on slot markers

Show indicated air speed on slot markers

Enable Altitude Filter (ft): 0

20000

Airspace and Routes



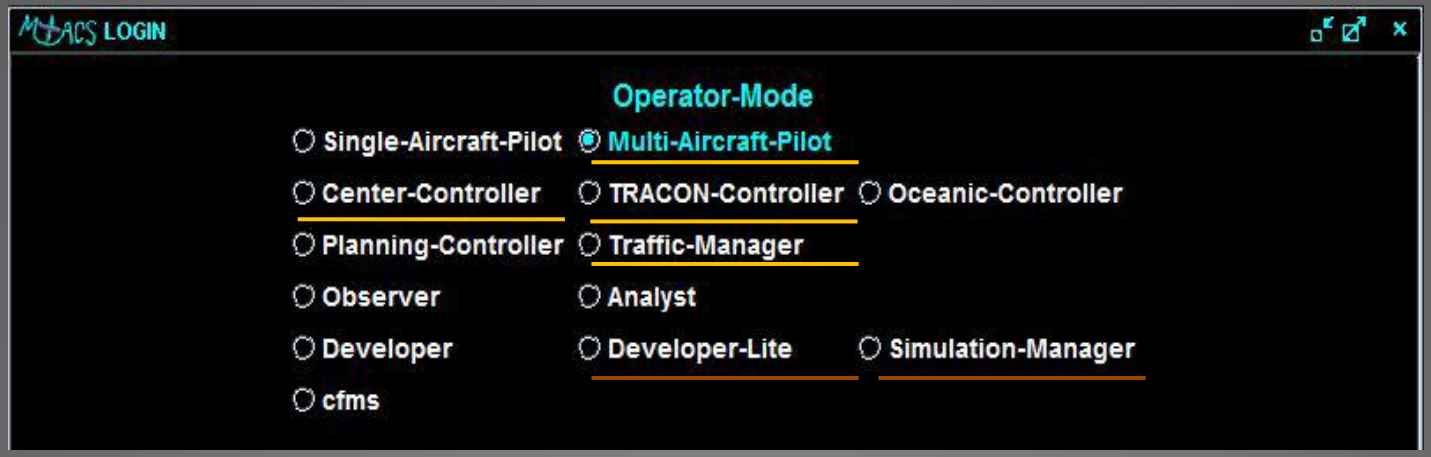
- TRACON, Center, Ghost, Tower controllers (, and MACS and ASTOR pilots)

- Continuous RNAV routes to DFW17C
- Approx. 2.4° descent angle to allow for speed control
- Nominal speed/altitude restrictions

Position Selection

- Airspace selection will determine which basic positions and operator modes are needed
- Basic MACS positions :
  - Simulation Manager
  - Sector controllers (Center- or, TRACON controller)
  - Ghost controller(s)
  - Pseudo pilots
- Other positions
  - Area supervisor
  - Observer stations
- 13 Operator modes in MACS: provide specific functionalities for pilots, controllers, simulation support or, researchers

Choosing the Operator Mode

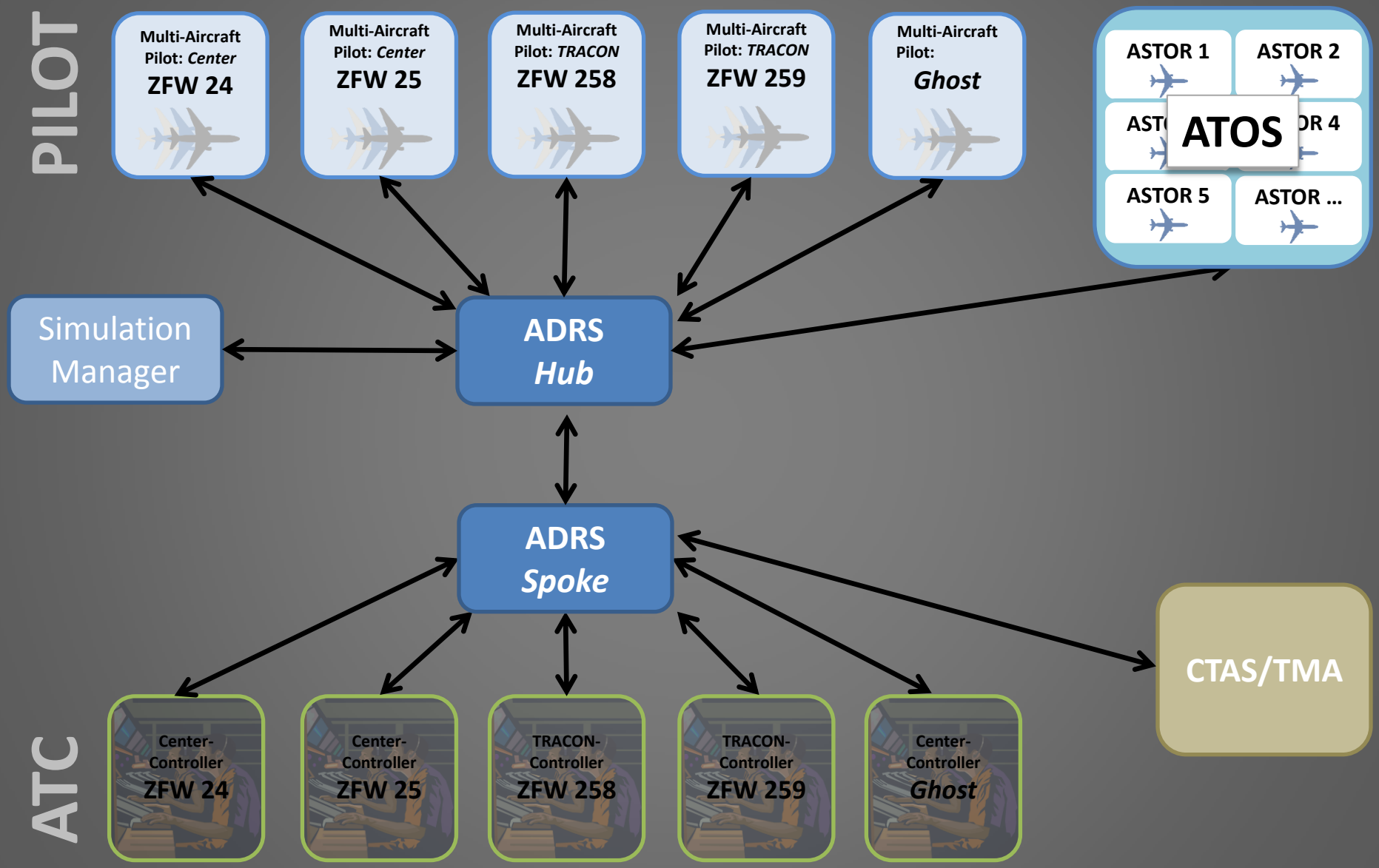


CA1:

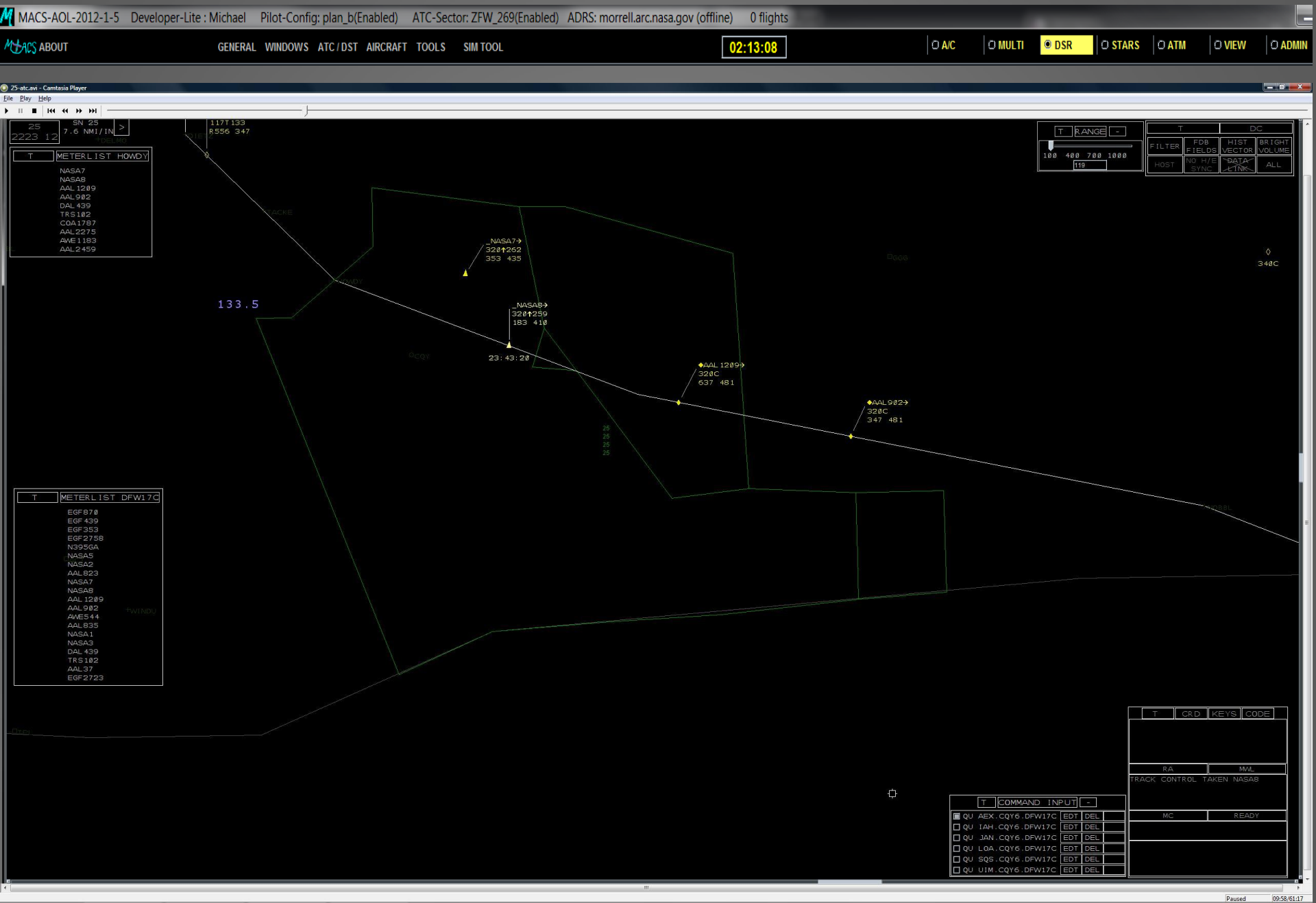
- **Simulation Manager** (simulation control)
- **Multi-Aircraft Pilot**
- **TRACON Controller** (sectors 258, 264, …)
- **Center-controller** (sectors 24, 25, 75, and ghost station)

- ***Traffic Manager*** *(additional views for wall projection)*
- ***Developer Lite*** *(offline scenario development)*

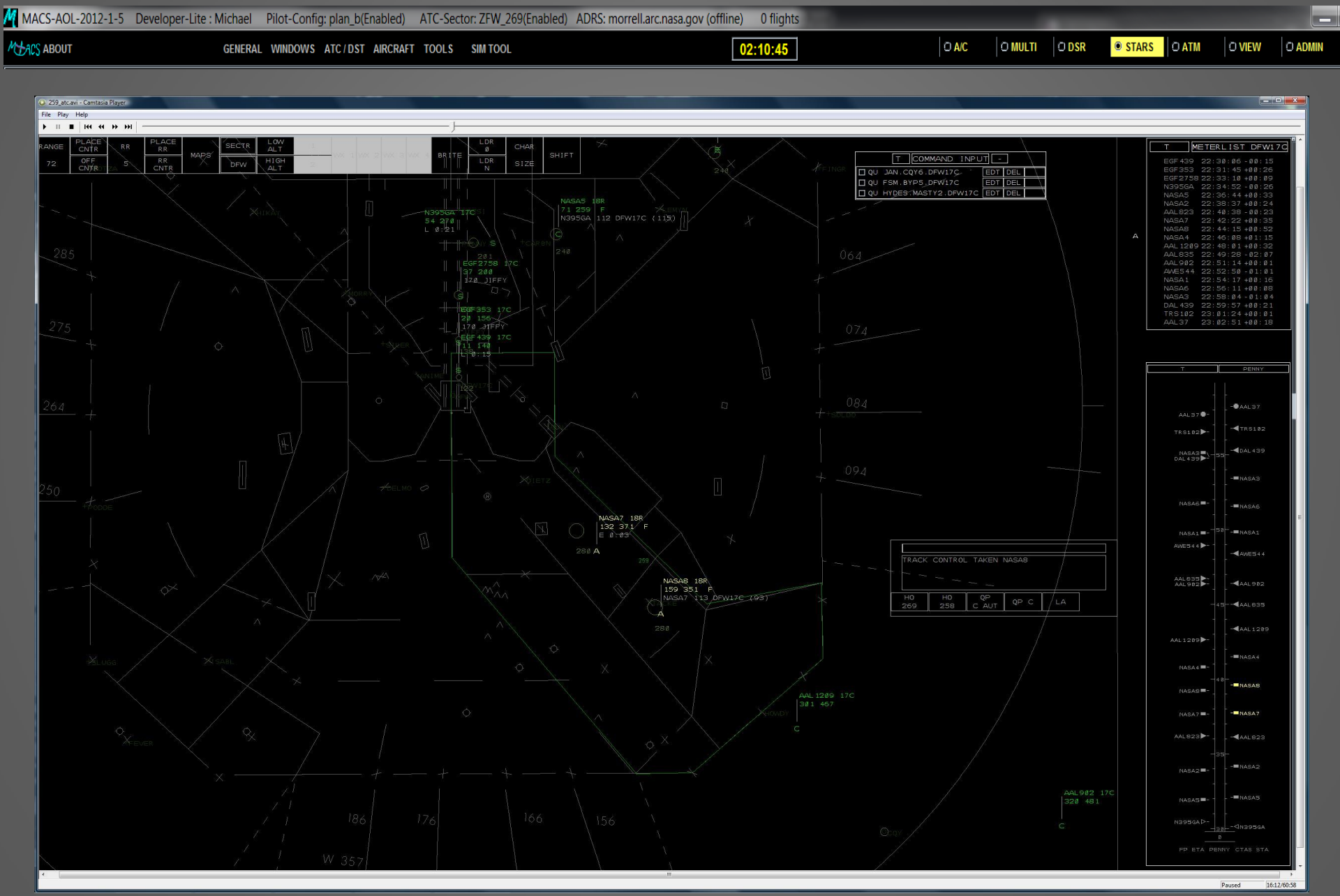
More information under: https://aol1.arc.nasa.gov:8443/display/macs/Getting+started+with+MACS


PILOT
Multi-Aircraft Pilot: *Center* ZFW 24
Multi-Aircraft Pilot: *Center* ZFW 25
Multi-Aircraft Pilot: *TRACON* ZFW 258
Multi-Aircraft Pilot: *TRACON* ZFW 259
Multi-Aircraft Pilot: *Ghost*
ASTOR 1
ASTOR 2
ATOS
ASTOR 5
ASTOR ...
Simulation Manager
ADRS *Hub*
ADRS *Spoke*
CTAS/TMA
ATC
Center-Controller ZFW 24
Center-Controller ZFW 25
TRACON-Controller ZFW 258
TRACON-Controller ZFW 259
Center-Controller *Ghost*

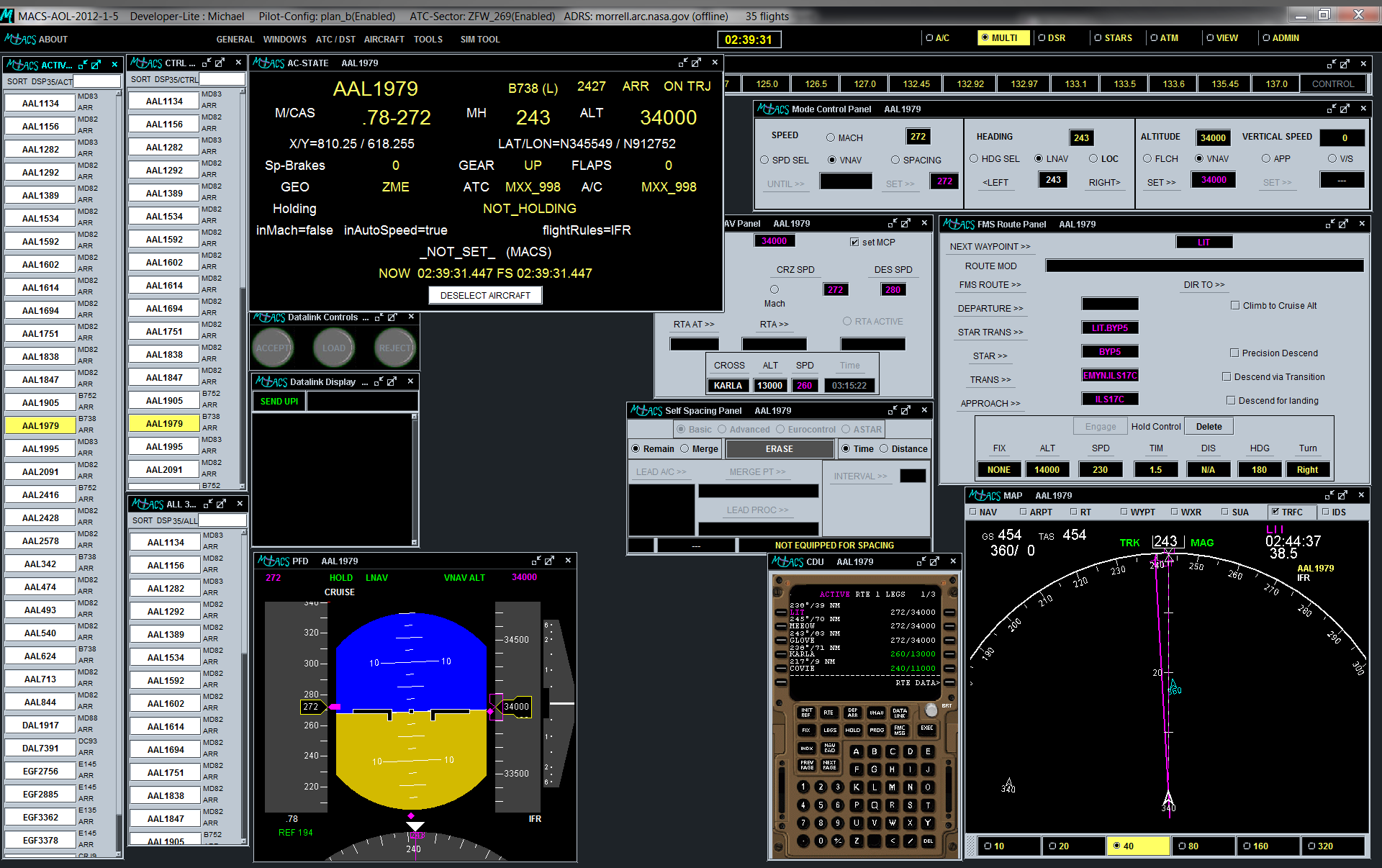
Examples Controller Stations: Center controller (DSR)



Examples Controller Stations: TRACON controller (STARS)



Example Stations: Pseudo Pilot Station



Controller Tasks

Ghost controller:

- Initialize handoff (HO) to center controllers
- Advise pilot to switch to respective frequency (once HO was taken)

Center controllers:

- Take HO from ghost
- Clear for approach ("AAL123 cleared via the MASTY2 arrival to runway 17C")
- Condition flow (speed advisories, vectors if necessary)
- Advise IM spacing clearance (if applicable)
- Initialize HO to TRACON feeder sector
- Advise pilot to switch to respective frequency (once HO was taken)

Controller Tasks

TRACON controller (Feeder)

- Take HO from Center
- Clear for approach ("AAL123 continue via the MASTY2 arrival to runway 17C")
- Reduce schedule errors (speed advisories, if necessary vectors) and monitor schedule conformance using the CMS tools
- If not yet done advise IM spacing clearance (if applicable)
- Initialize HO to Final
- Advise pilot to switch to respective frequency (once HO was taken)

TRACON controller (FINAL)

- Take HO from Feeder
- Fine-tune schedule conformance and keep monitoring
- Ensure sufficient spacing between aircraft on runway threshold
- Initialize HO to tower
- Advise pilot to switch to respective frequency (once HO was taken)

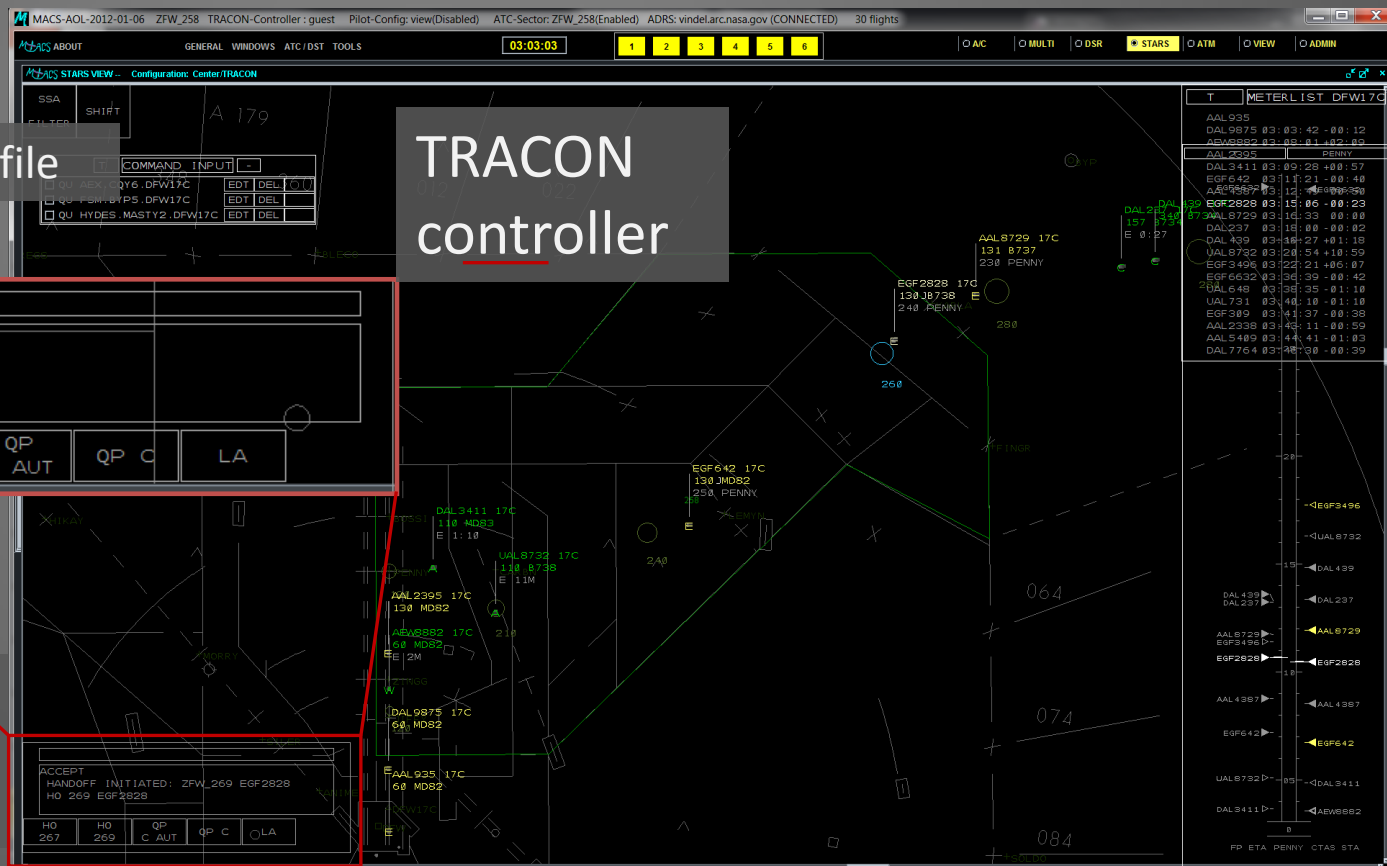
Handoffs in MACS

```
#ZFW_24
ZFW_24 134.7
#
#ZFW_25
ZFW_25 136.8
#
#ZFW_75
ZFW_75 137.5
#
#----------------------
#TRACON
#----------------------
#
#ZFW_264 - Feeder NW - FW1 South Flow
ZFW_264 119.8
#
#ZFW_258 - Feeder NE - FE1 South Flow
ZFW_258 125.0
#
#ZFW_259 - Feeder SE - FE2 South Flow
ZFW_259 133.5
#
#ZFW_269 - Approach CE - AR2 South Flow
ZFW_269 127.0
```

Sector_frequency_table file

Flightdeck

TRACON controller



Also: Ownership in ATC_DST Configuration Sector Setup

Questions and Answers

Contact:

Michael Kupfer michael.kupfer@nasa.gov (650)-604-4624

Pilot Tasks

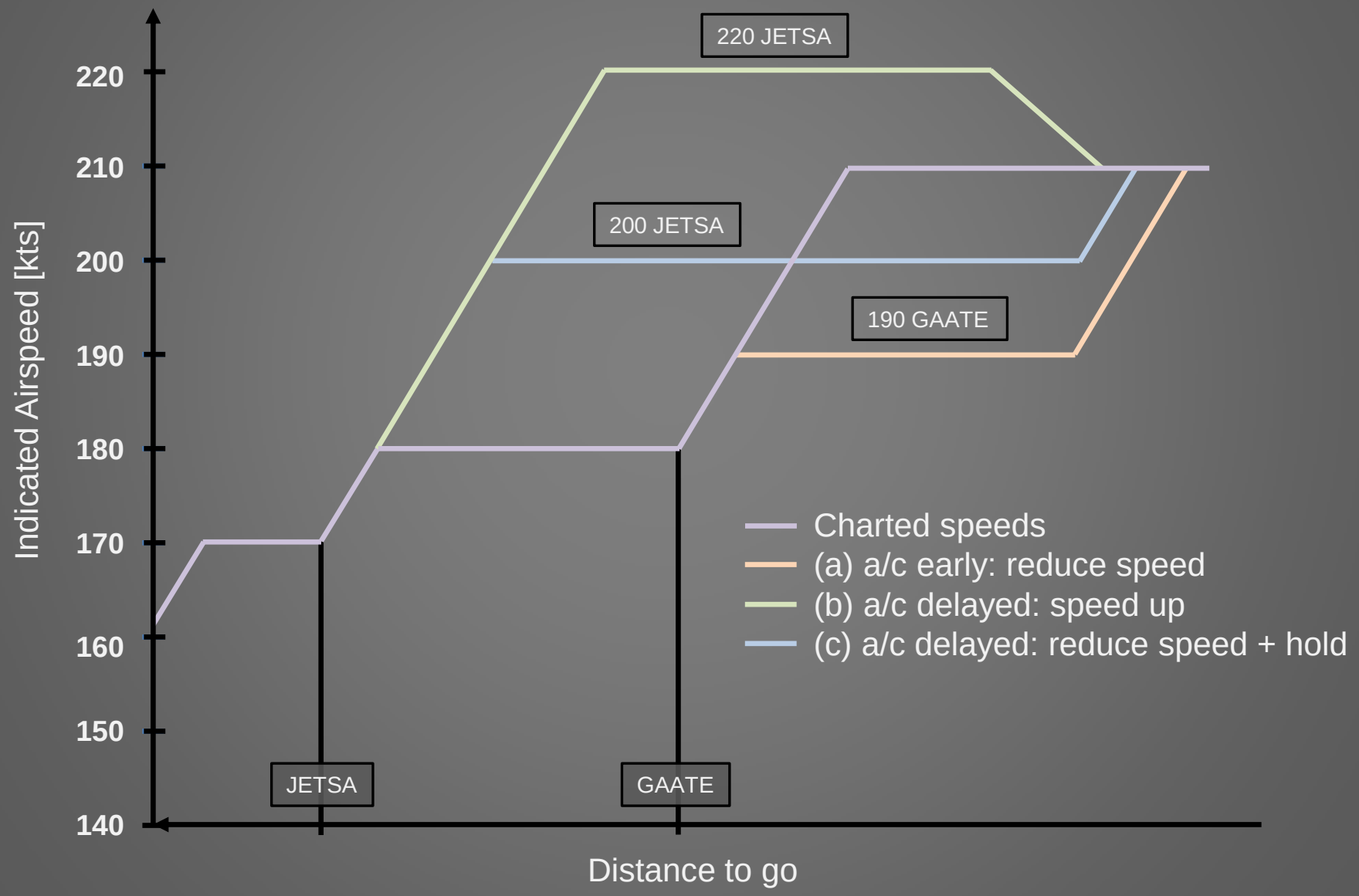
Ghost Pilot

- Expected ATC clearances:
  - “AAL137 cleared for the MASTY2 arrival”
  - “AAL137 contact Center on 134.7”

Center Pilot

- Radio Check-in
- Expected ATC clearances:
  - “AAL137 maintain 270kts”
  - “AAL137 cleared for the MASTY2 arrival”
  - “AAL137 contact approach on 119.8”

Feeder Pilot

- Radio Check-in
- Expected ATC clearances:
  - “AAL137 continue via the MASTY2 arrival”
  - “AAL137 maintain speed 210kts”
  - “AAL137 contact approach on 119.8”

Speed Advisory Examples