Integration of UAV into ATC/ATM
Introduction in the simulation demonstration

Workshop 19.02.2004

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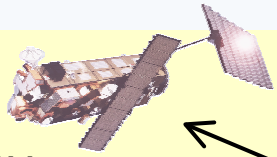
Simulation Concept for UAV Integration



Relay

Comm delay

relay C³ link

Avionics System
(NAV / FMS / AFCS / FTS)

Other aircraft

C-UAV

strobe lights
TCAS II
sense & avoid

VHF COM
SSR transponder

direct C³ link

UAV Control Station

telephone

Air Traffic Control

UAV events to be evaluated by simulations

- Loss of Thrust (or other emergency case) : squawk 7700
- Communication Failure
  - Transmitter Failure; squawk 7600
  - Total Communication Failure; squawk 7600
- Data-Link Loss; squawk 7600
- Communication Failure and Data-Link Loss; squawk 7600
- Transponder Failure (loss of altitude information)
- Avoidance of a severe weather (Thunderstorm)
- Loss of Separation (to be defined)

Objectives of ATC/ATM Real Time Simulations

Evaluation of the UAV integration concept:

- Normal operations
- Emergency Operations:
  - Standard emergency procedures:
    - Comm Loss
    - Thrust Loss
  - UAV specific emergency procedures
    - (additional emergency codes)

Investigation of UAV specifics:

- Communication delay for voice and data

Evaluation Methods

Subjective Measurements

- ISA (Instanteneous Self Assessment)

Objective Measurements

- Time for Communication
- Others

Questionnaires

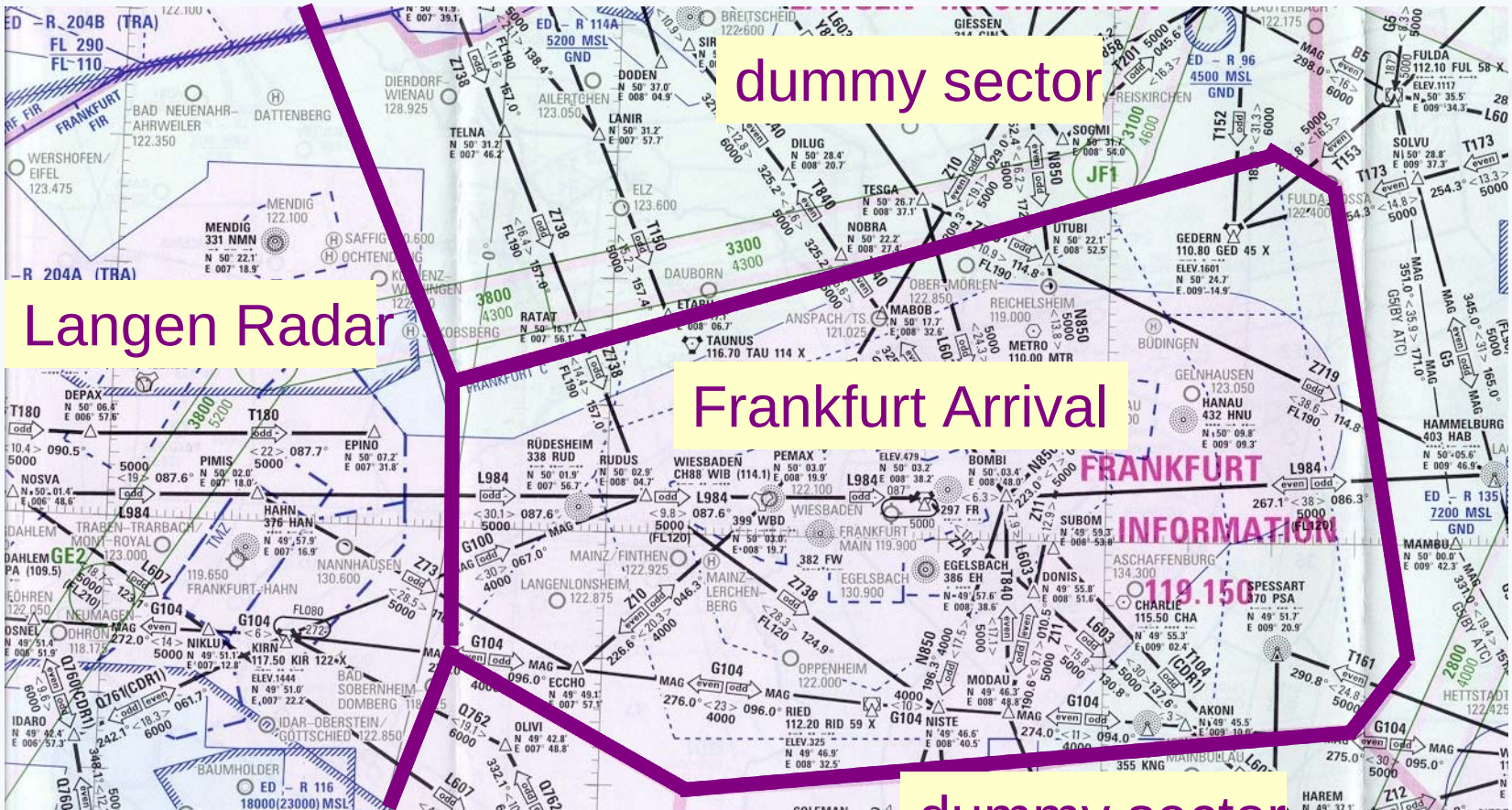
- Post Run Debrief
  - NASA-TLX
  - DFS questionnaire
- Final Debrief Questionnaire

Simulated Centres

- Frankfurt Arrival (ARR) and Frankfurt Area Control Centre (ACC)
  - west-sector "Langen Radar"
  - radar approach controller "Frankfurt Arrival"

Simulated Airspace

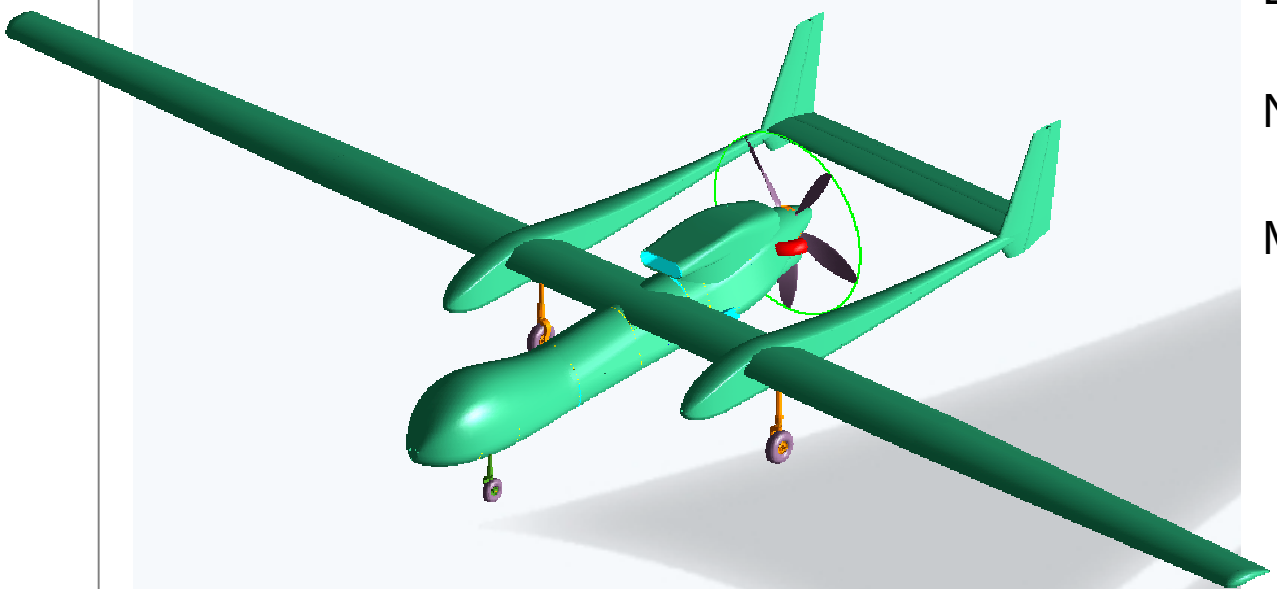
FIR Frankfurt: TMA Frankfurt & Sector West (modified)



Simulated Traffic

- Arrival traffic EDDF
- Departure traffic EDDF
- Overflights
- UAV Traffic
  Fixed wing MALE departure from West or North from Frankfurt
  Mission requires crossing of TMA Frankfurt

Simulated MALE UAV

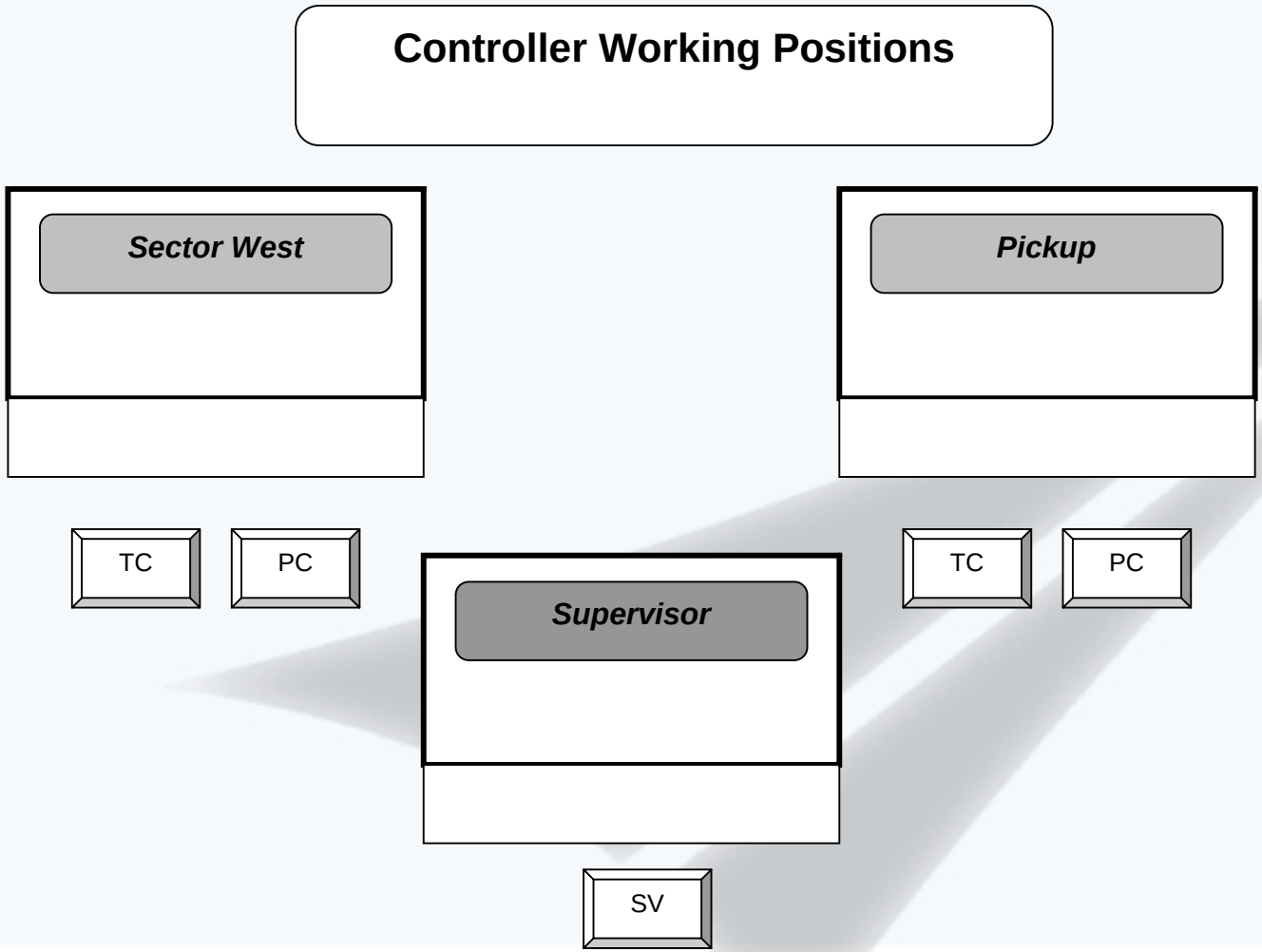


Wing span (m)	22.6
Length (m)	10.68
Normal cruise (kcas)	110
Max. ceiling (ft)	45000

Controller Working Positions

- Sector West: Langen Radar
- Sector North: dummy
- Sector South: dummy
- TMA: Frankfurt Arrival

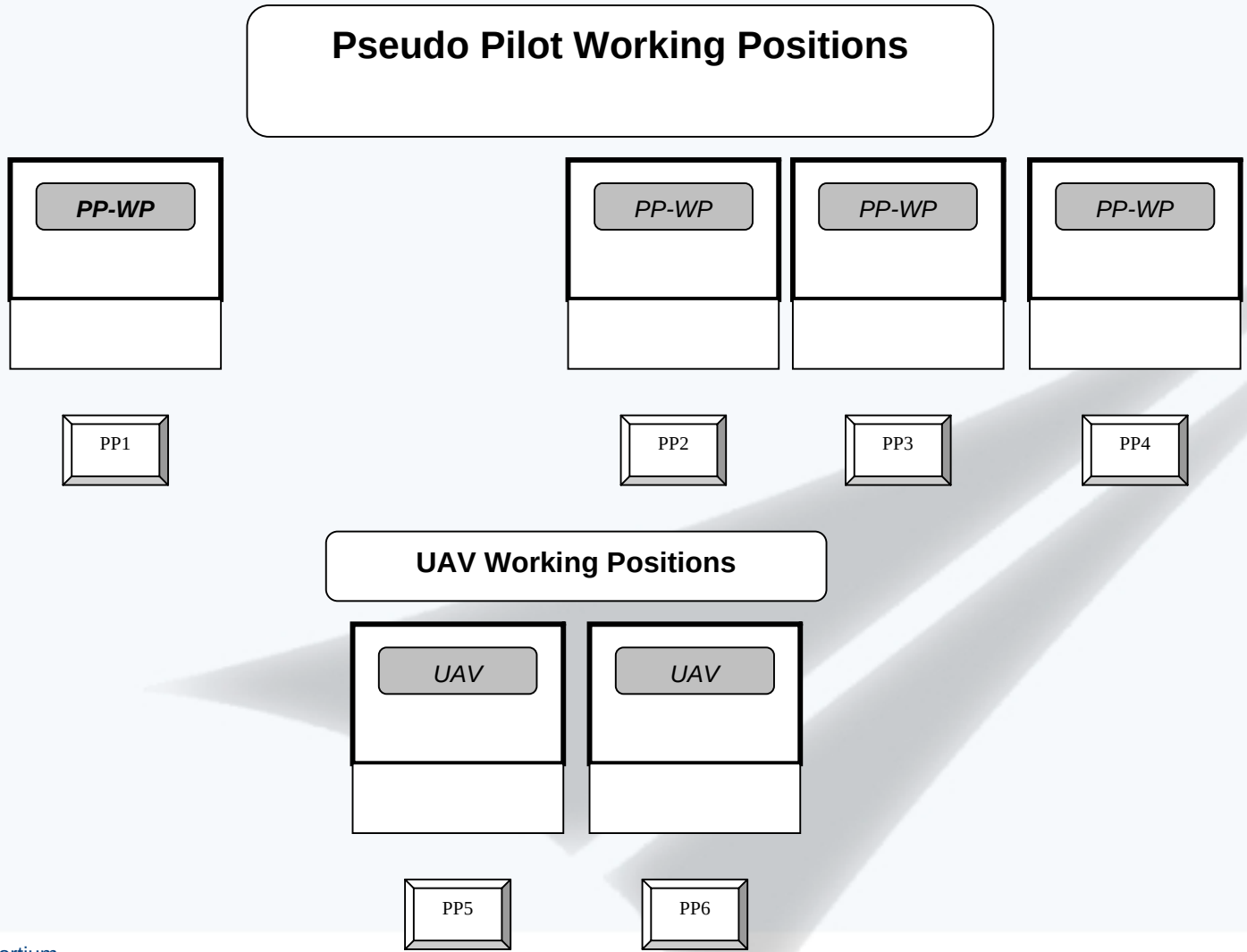
USICO Simulation Room Layout, CWPs



Pseudo Pilot Working Positions

- Sector West: 1 pseudo pilot
- Sector North: unmanned, dummy traffic
- Sector South: unmanned, dummy traffic
- TMA: 3 pseudo pilots
- additional: UAV pilots

USICO Simulation Room Layout, Pseudo Pilots



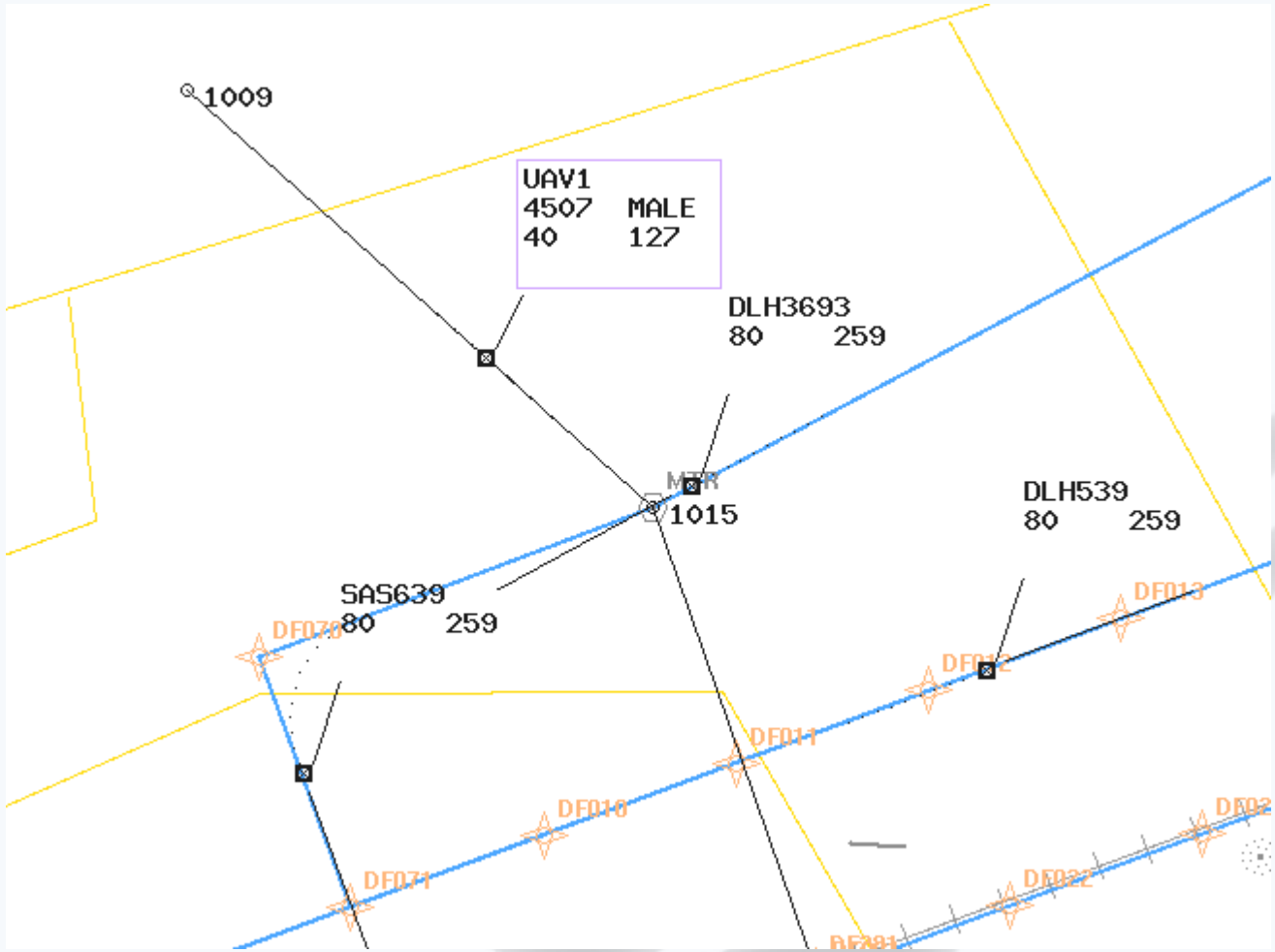
Simulation Environment

Based on ATMOS-2-CASS.

Radar

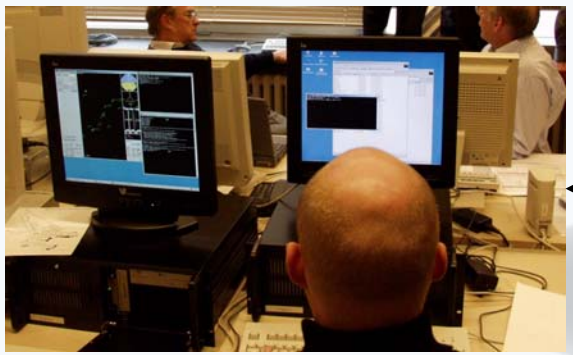
- Horizontal representation of aircraft positions.
- Aircraft labels: callsign, altitude, groundspeed.
- Scale factor, geographical area selected by the controller.
- Optional display items: boundaries, sectors, ATC routes, names of fixes, range rings

Label



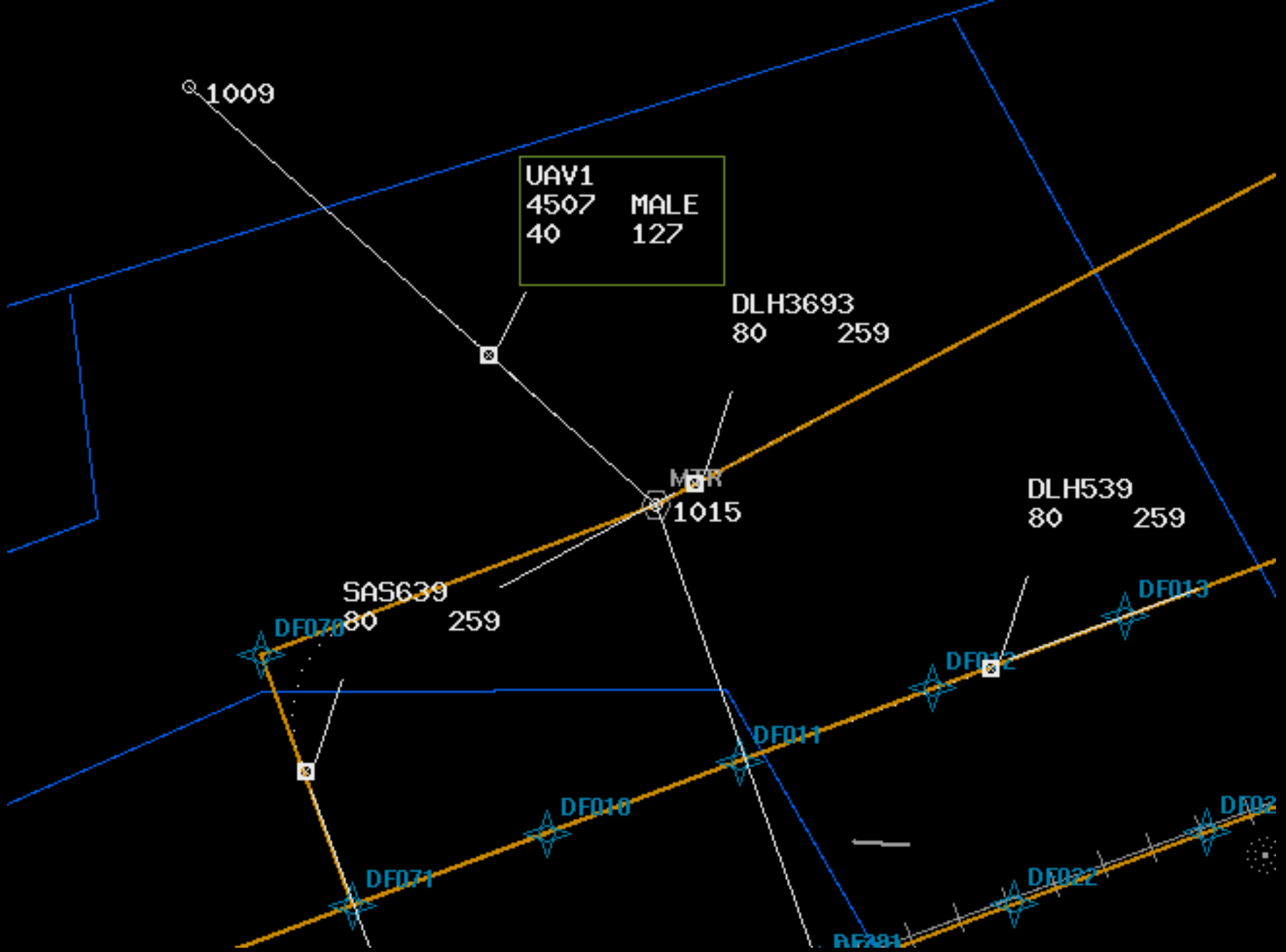
Simulation Setup

Pseudo Pilots



UAV Pilot (FHS Sim)

Air Traffic Management and Operations Simulator ATMOS


1009
UAV1
4507 MALE
40 127
DLH3693
80 259
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DF013
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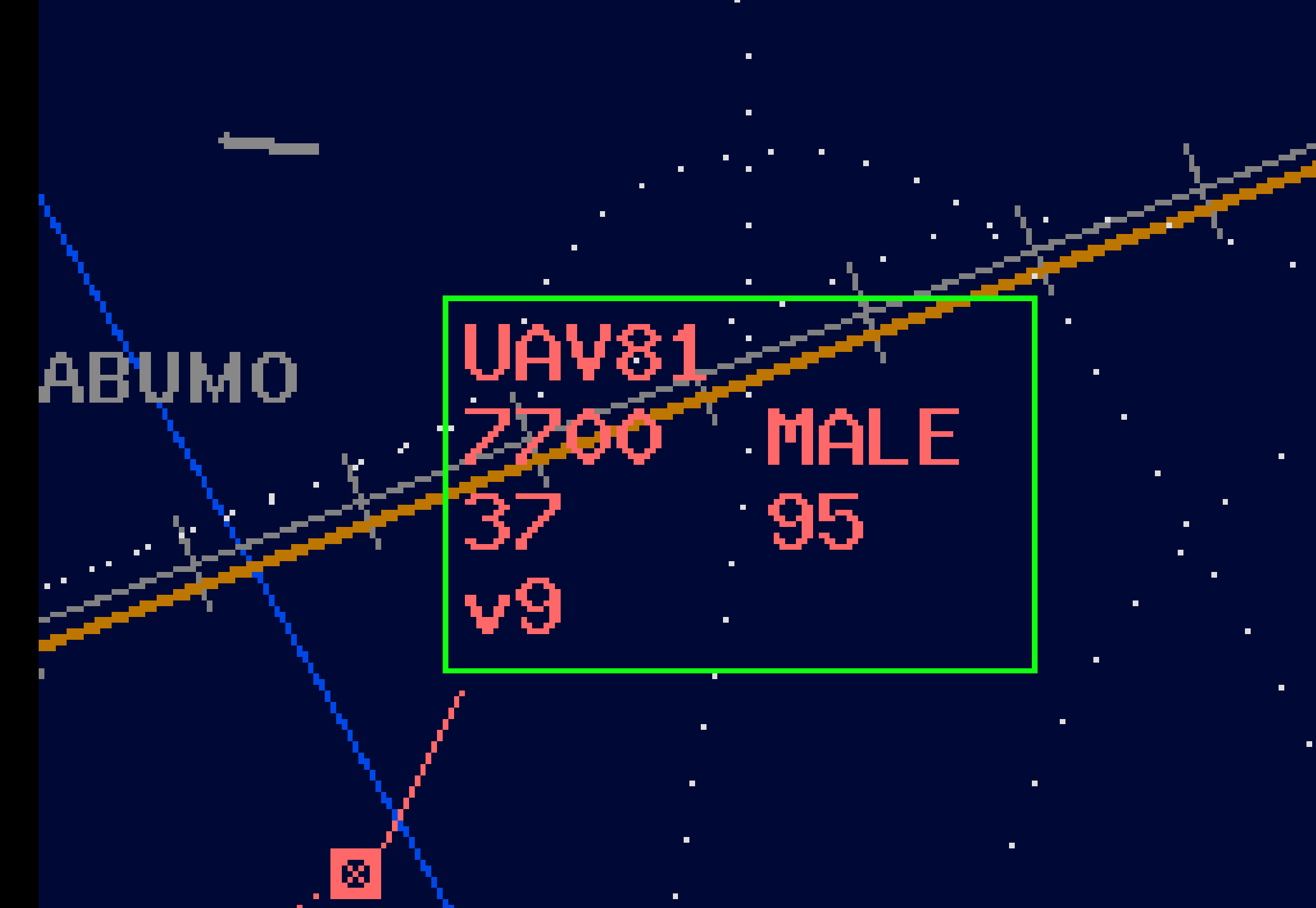
DF071
DF070


ABUMO
UAV81
7200
MALE
37
95
v9

Simulation Environment

Communication

- Telephone communication between sector controller and arrival controller
- Telephone communication between controller and UAV pilot if requested

Simulated Radio Telephony

- Radio telephony for the controller / pseudo pilot voice communication
  specially designed intercommunication device
  operation over wire link
- Communication delay for satellite link is implemented:
  - 1.5 s

USICO Simulation Runs (Example)

Scenario No.	1
Name	usico_1_uav_ef
Scenario Description	Engine failure of an UAV
UAV Mission Description	tbd
Simulation Area	FIR Frankfurt
Working Positions	

Controller Working Position

EDDF, West Sector:	2 controller (TC, PC)
EDDF, South Sector	dummy
EDDF, North Sector	dummy
EDDF, Arrival	2 controller (TC, PC)
EDDF, Feeder	not used

Pseudo Pilot Working Position

Normal Aircraft	4 pseudo pilots
UAV Traffic	1 UAV pseudo pilot

USICO Simulation Runs (Example cont)

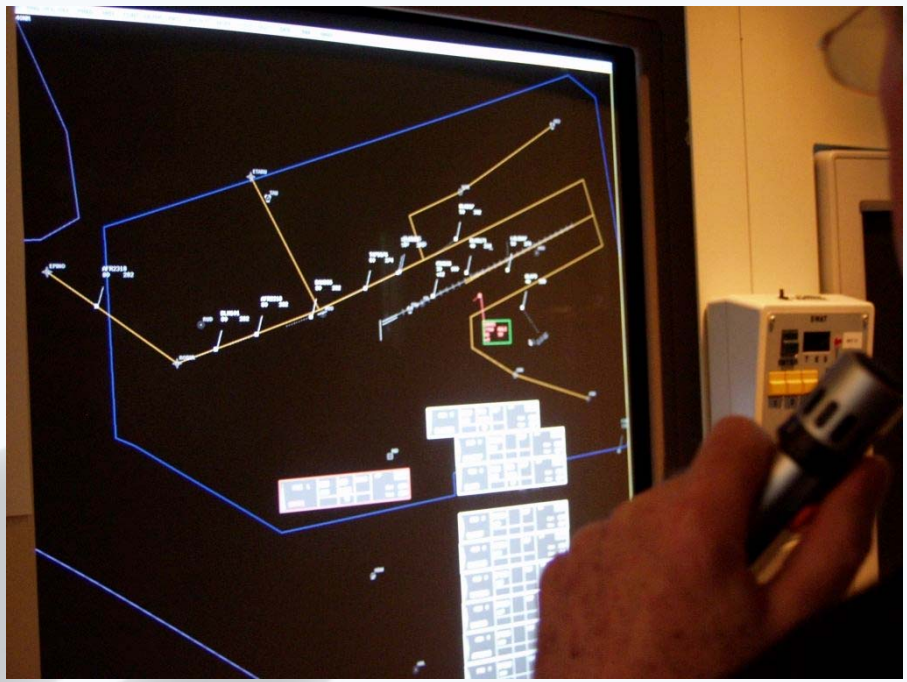
Statistics

Total Number of aircraft:	40
Arrival aircrafts:	30
Overflights:	10
UAV:	1

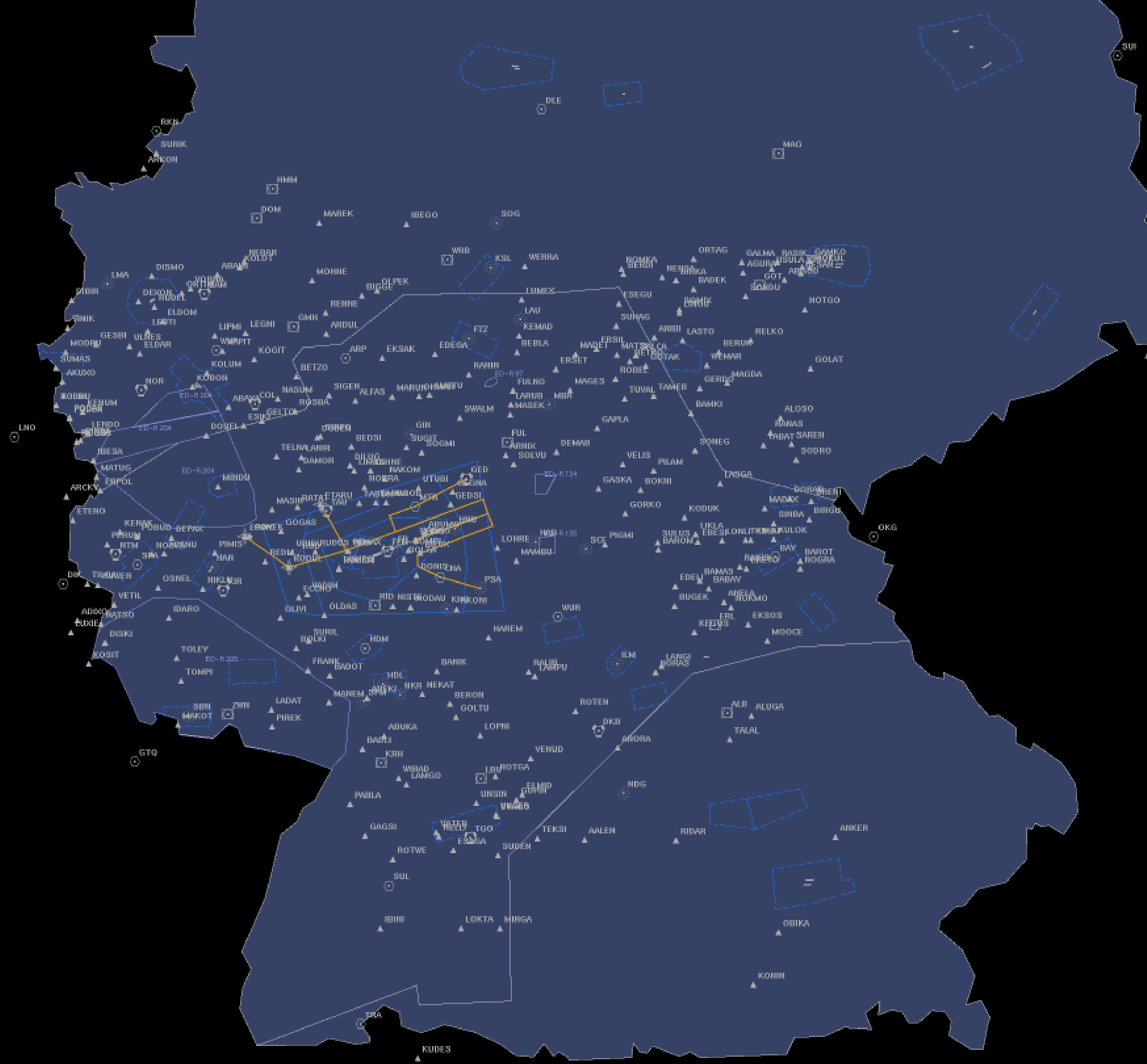
Percentage

Weight Classes		Sectors
H	30 %,	33 % West
M	60 %,	33 % North
L	10 %	33 % South

Let‘s start



SAVE



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RELKO
ALOSO
SONEG
LNO
OKG
WUR
HAREM
ROTEN
DKB
NDG
ALB
ALUGA
TALAL
LOPNI
VENUD
GTQ
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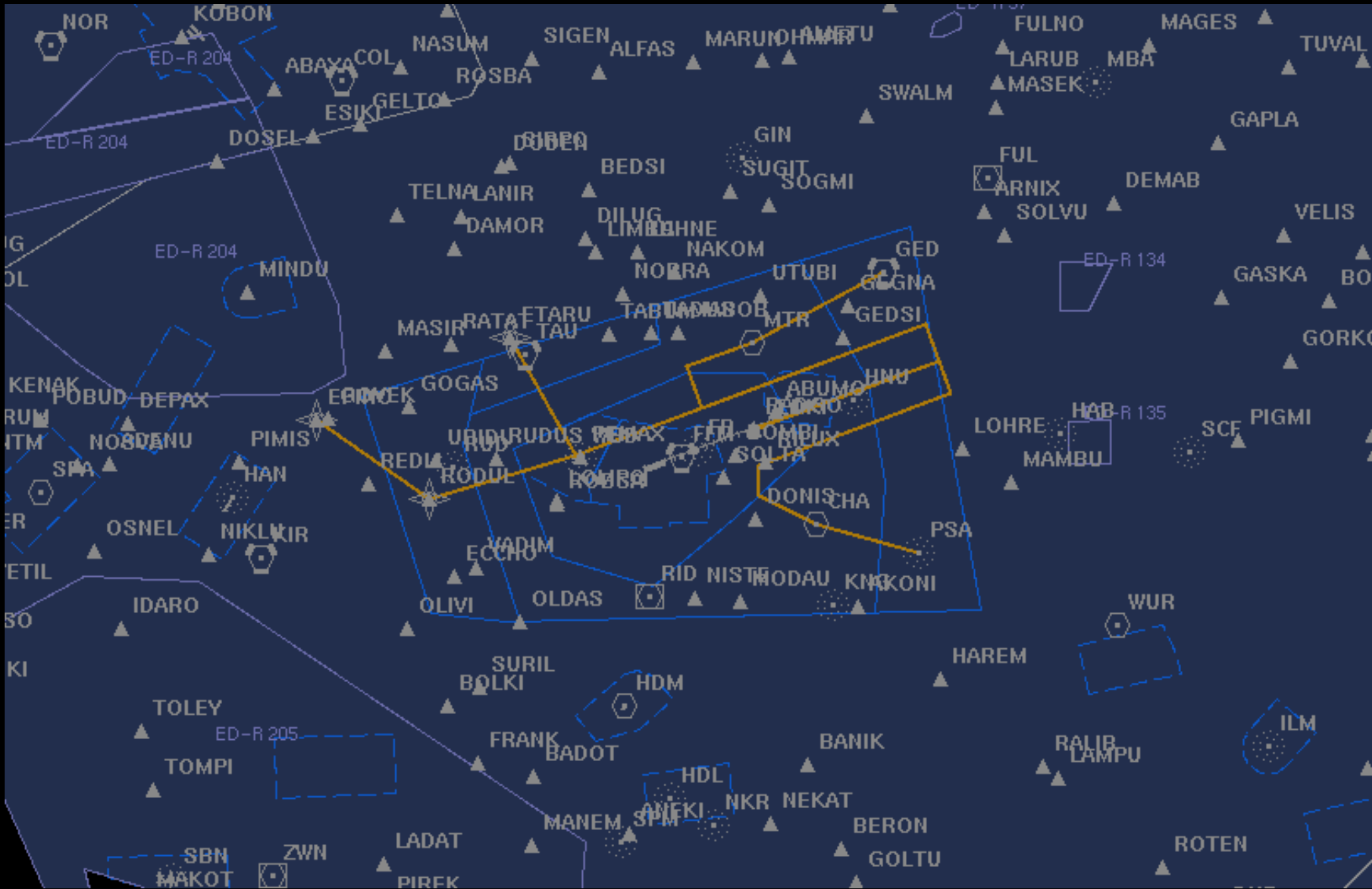
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HNU
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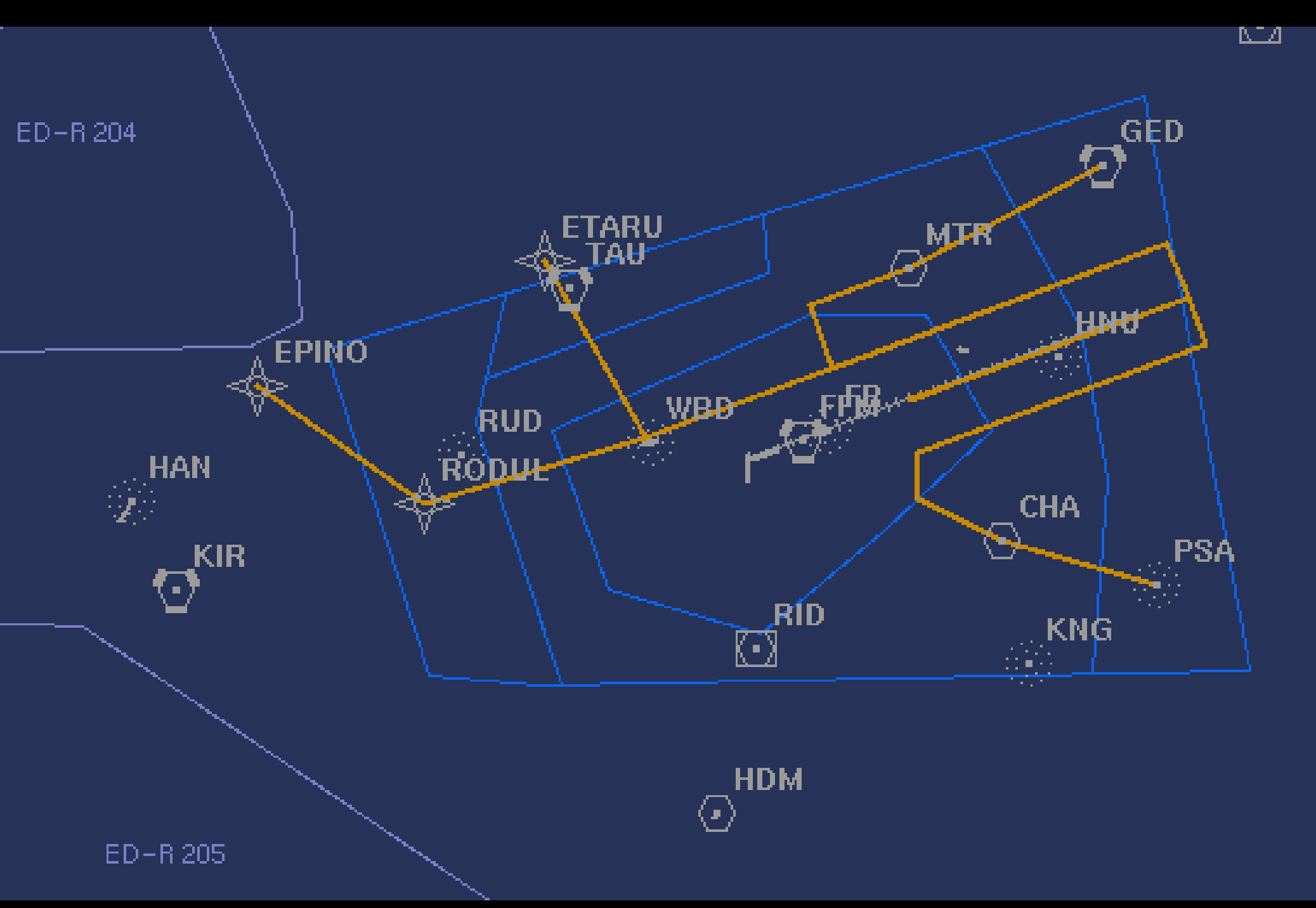
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SBI871
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v10
202
RADGO
EPDKI
FR
EFM
BOMBI
RILUX
SOLTA

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Demonstrations

Three Groups: G1, G2, G3

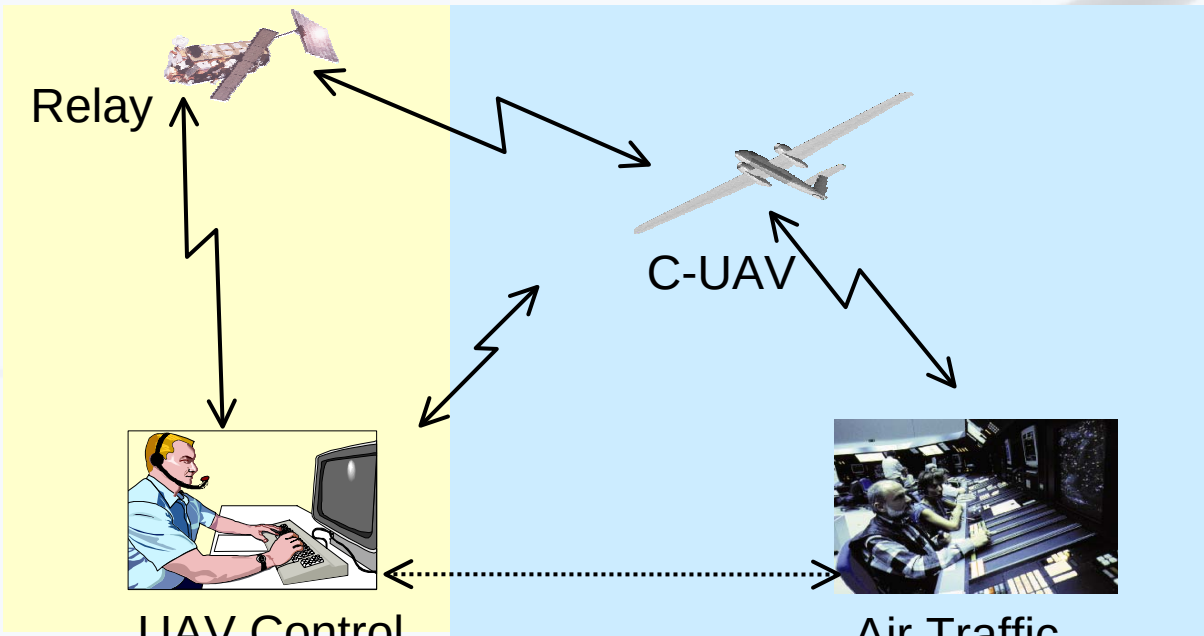
- ATM/ATC integration, Emergency procedures
- Collision Avoidance System
- Enhanced Vision Systems

All groups will see everything

Now: Lunch

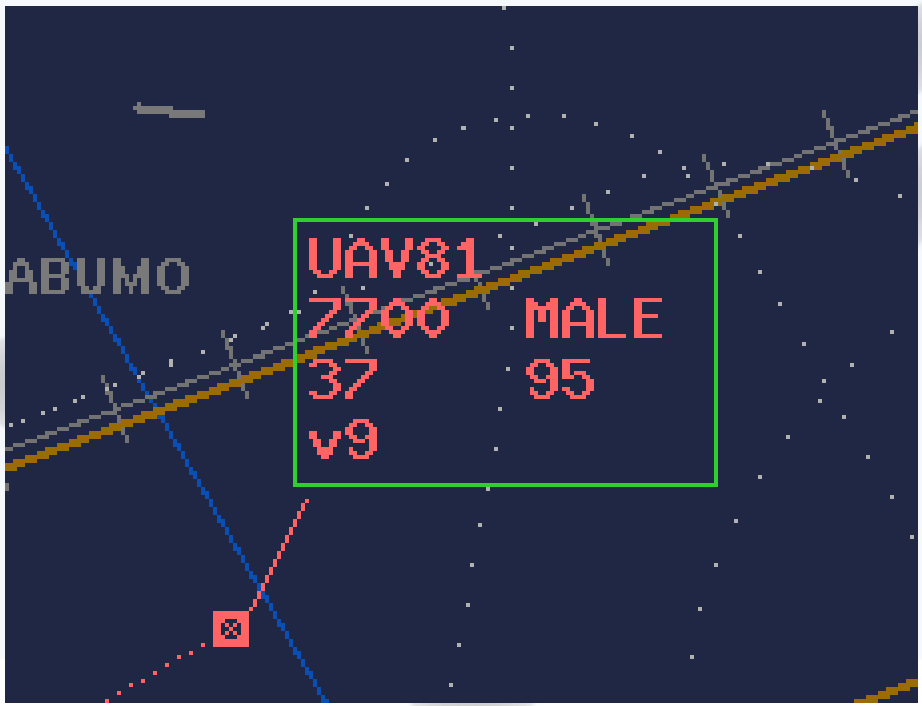
First Results
based on controllers‘s comments

- General
  No special problems with UAV in airspace
  Integration concept allows treatment of UAV like normal aircraft



First Results
based on controllers‘s comments (cont 1)

- Emergency Codes
  7600 for data link loss and comm loss appropriate
  7700 for unpredictable emergency behaviour only



First Results
based on controllers‘s comments (cont 2)

- Telephone comm between controller and UAVpilot is a benefit compared to manned aircraft

UAV Control Station

Air Traffic Control

Simulated Airspace

- FIR Frankfurt:
  - Sector West (modified)
  - TMA Frankfurt

Simulated Airports

USICO will simulate the approach traffic of Frankfurt (and Hahn or another potential UAV airfield)

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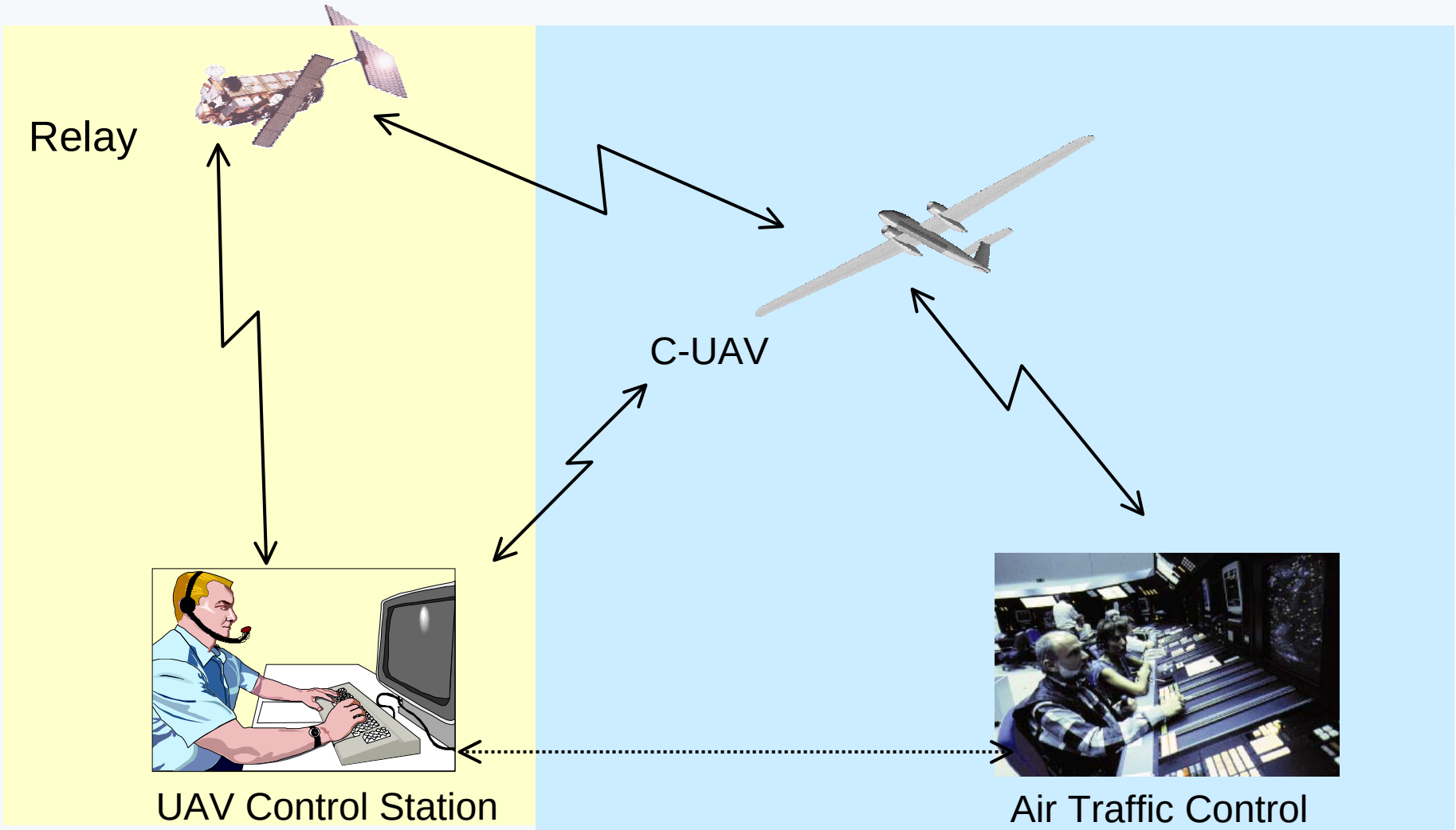

Simulation Concept for UAV Integration

UAV Control Station

Air Traffic Control