

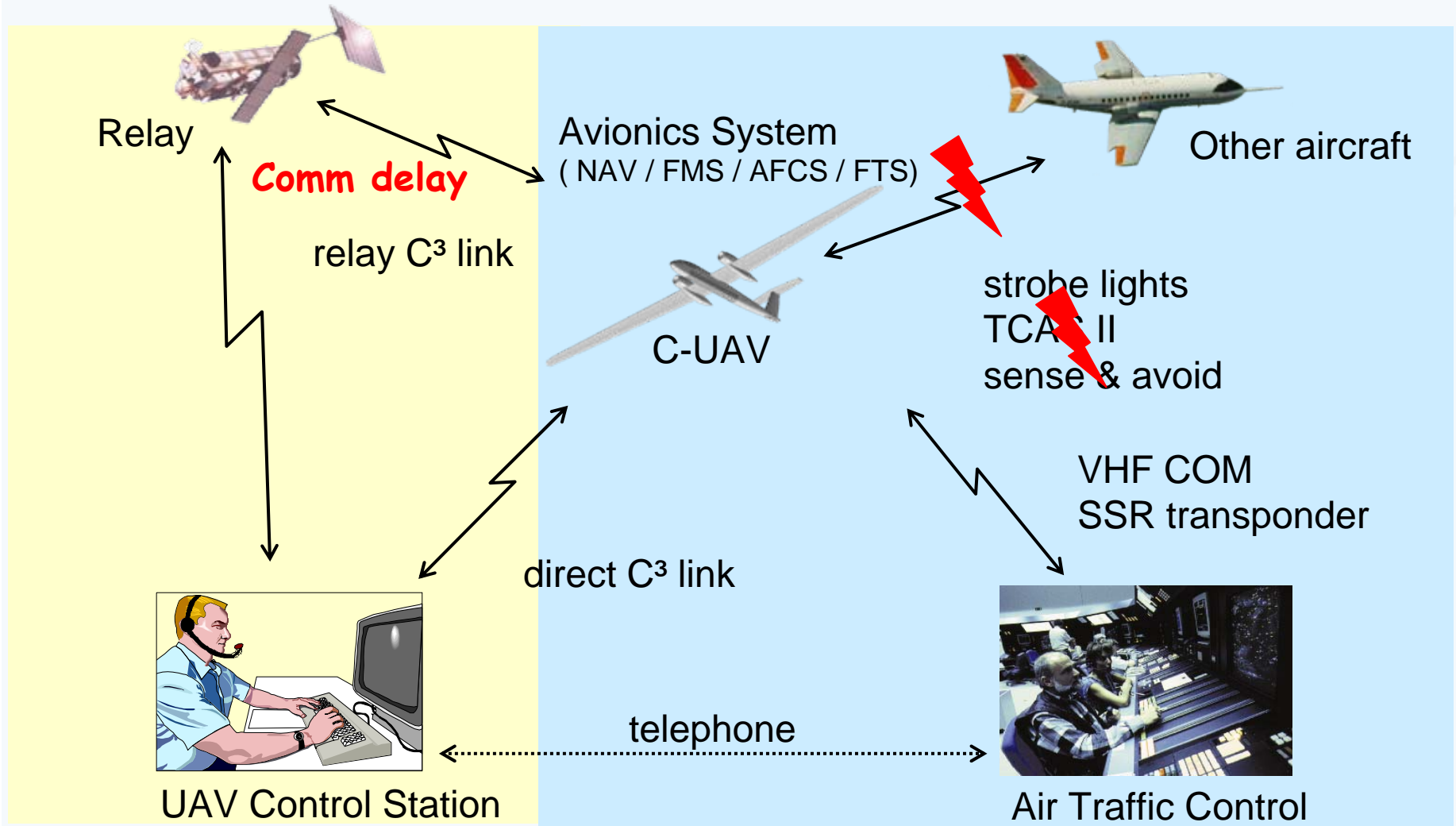
(UAV Safety Issues for Civil Operations)

# Integration of UAV into civil ATC/ATM ATM-Simulation

Braunschweig 2009-10-01

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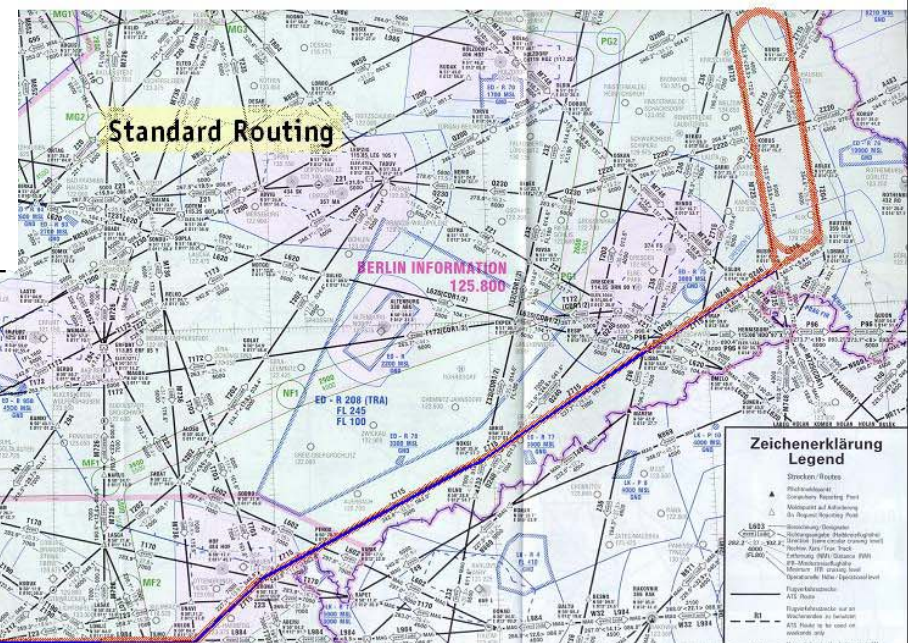
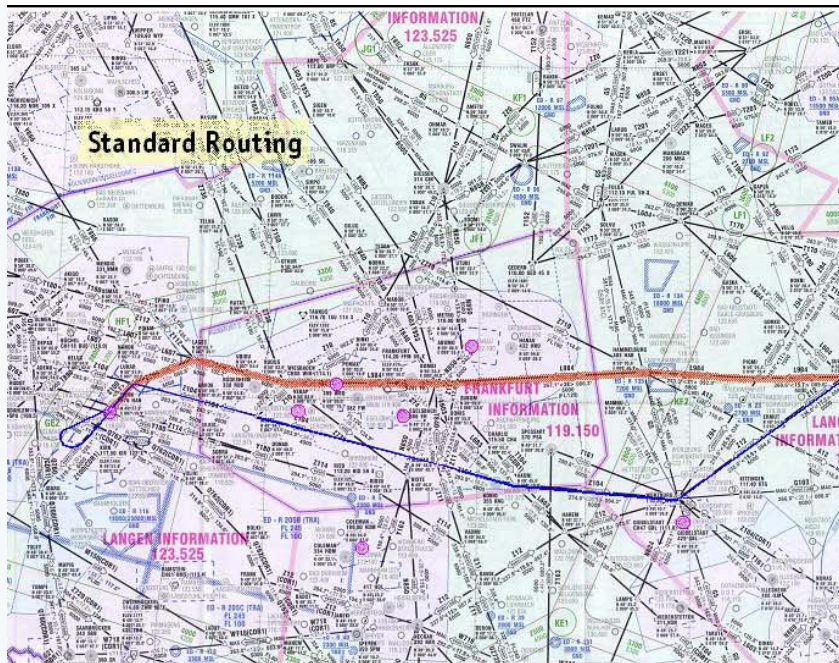
## Simulation Concept for UAV Integration



## Real Time Simulation

### Mission Scenario:

- Surveillance Mission of a MALE UAV
- from regional airport Frankfurt-Hahn
- to mission area north of Bautzen



### Scenario of Real Time Simulation:

- UAV crossing TMA Frankfurt on its outbound and inbound flight
- UAV emergencies within the TMA

## 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

## 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)

## Evaluation Methods

### Subjective Measurements

- ISA (Instantaneous Self Assessment)

### Objective Measurements

- Time for Communication
- Others

### Questionnaires

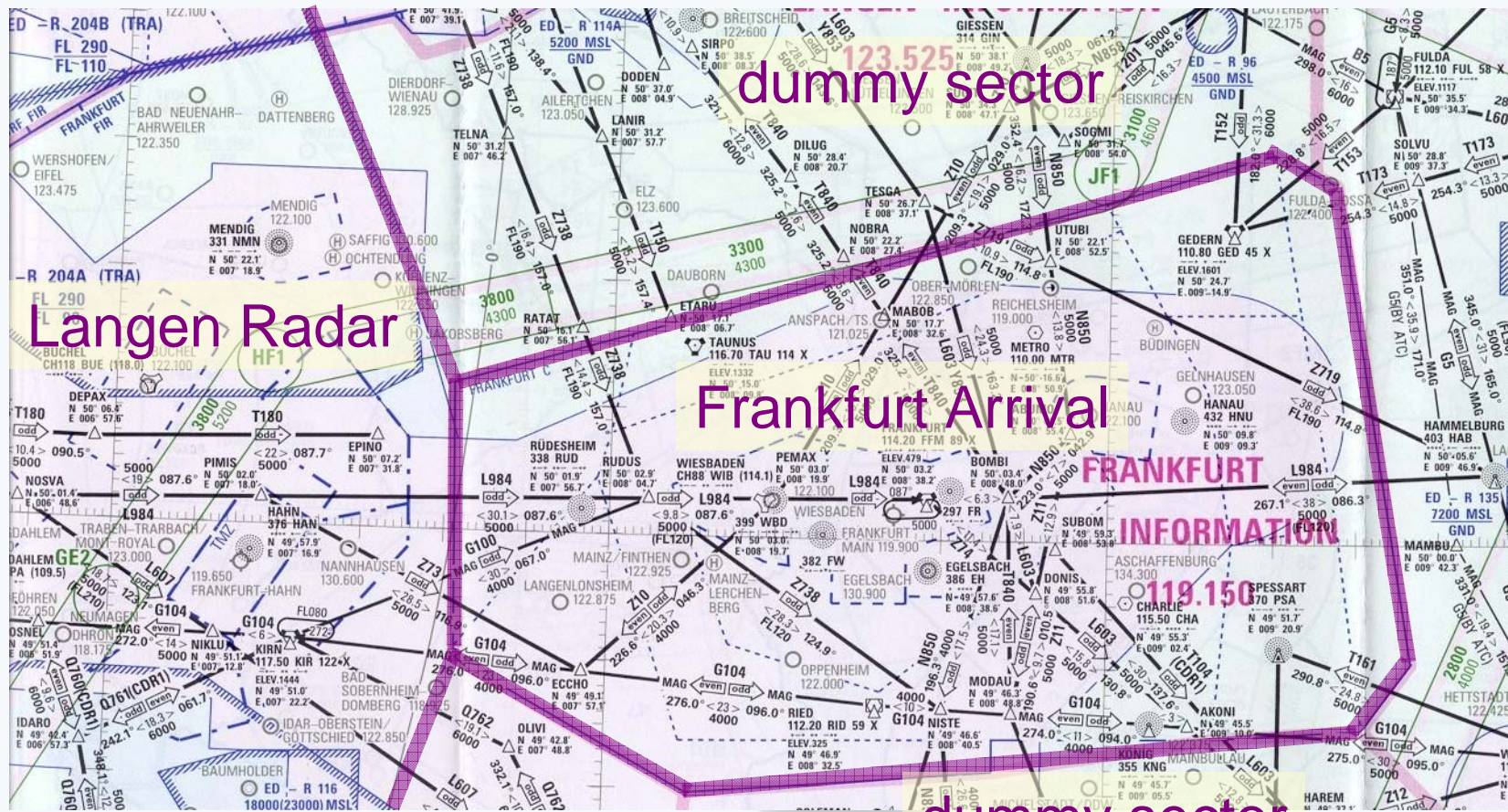
- Post Run Debrief
  - NASA-TLX
  - DFS questionnaire
- Final Debrief Questionnaire

## 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)

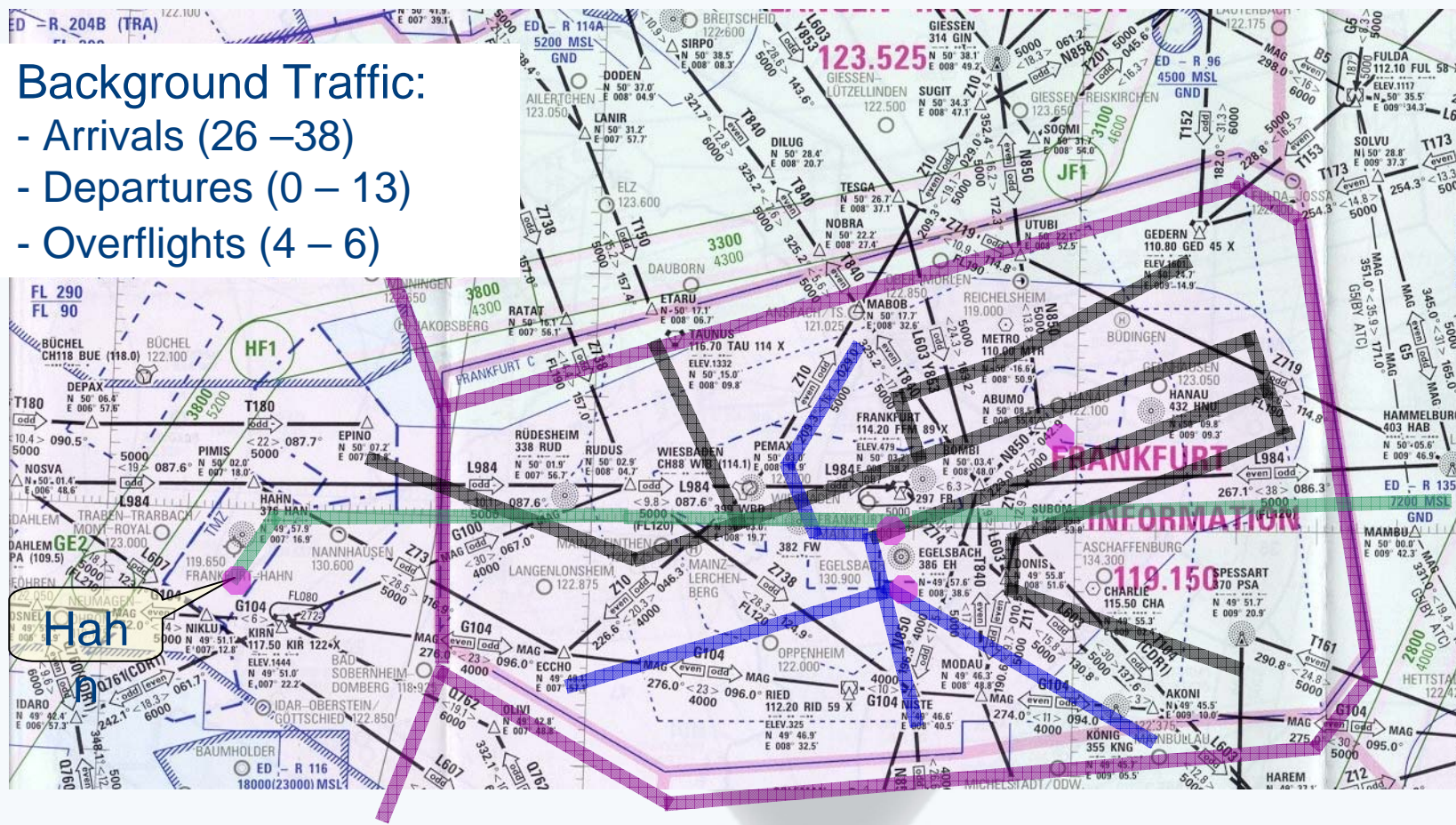




## Simulated Traffic

### Background Traffic:

- Arrivals (26 –38)
- Departures (0 – 13)
- Overflights (4 – 6)



## Simulated Traffic

- Arrival traffic EDDF
- Departure traffic EDDF
- Overflights
- UAV Traffic

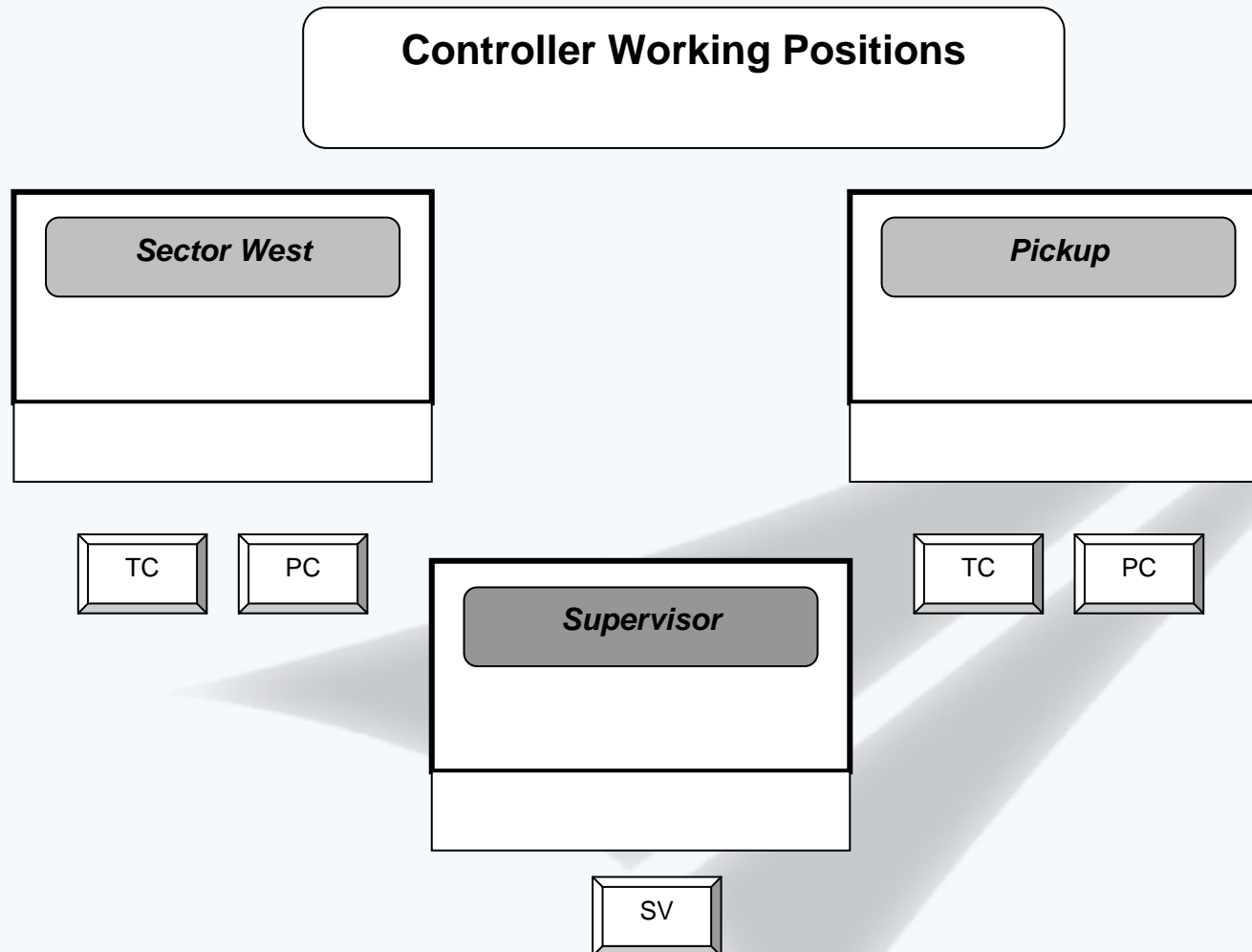
Fixed wing MALE departure from West or North from Frankfurt  
Mission requires crossing of TMA Frankfurt

## Simulated MALE UAV



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

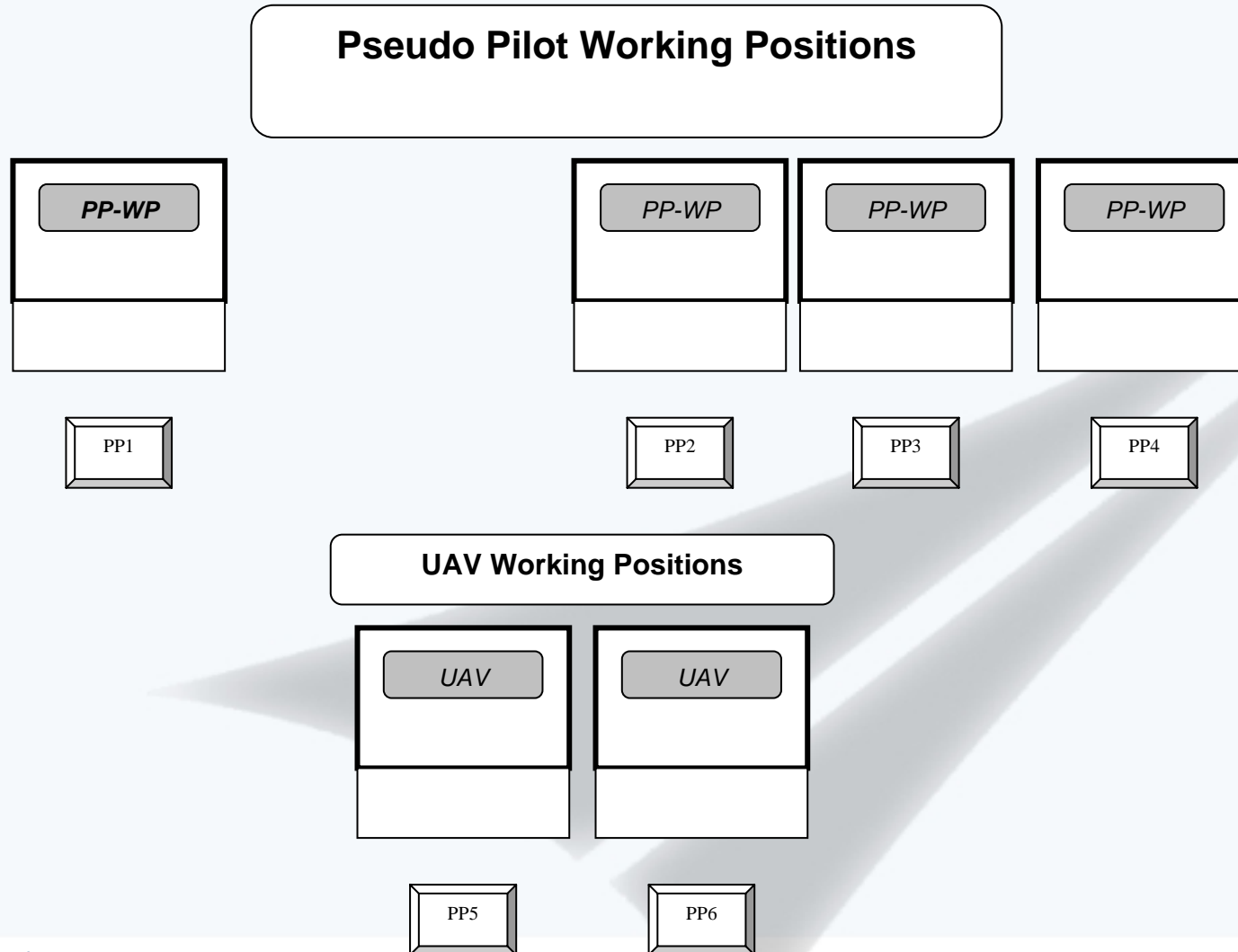
## USICO Simulation Room Layout, CWPs



## 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

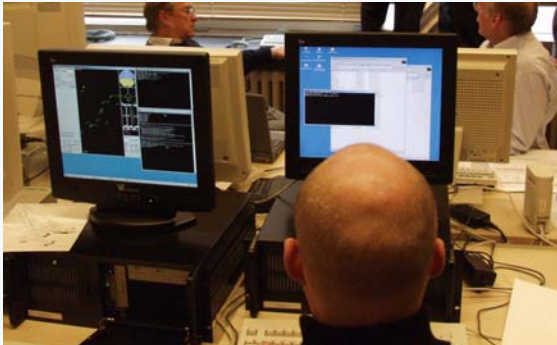
## USICO Simulation Room Layout, Pseudo Pilots



## Simulation Setup



**Pseudo Pilots**



**UAV Pilot (FHS Sim)**



**Air Traffic Management and Operations Simulator  
ATMOS**

1009

UAV1	4507	MALE
	40	127

DLH3693  
80 259

MTR  
1015

DLH539  
80 259

SAS639  
80 259

DF076

DF013

DF012

DF011

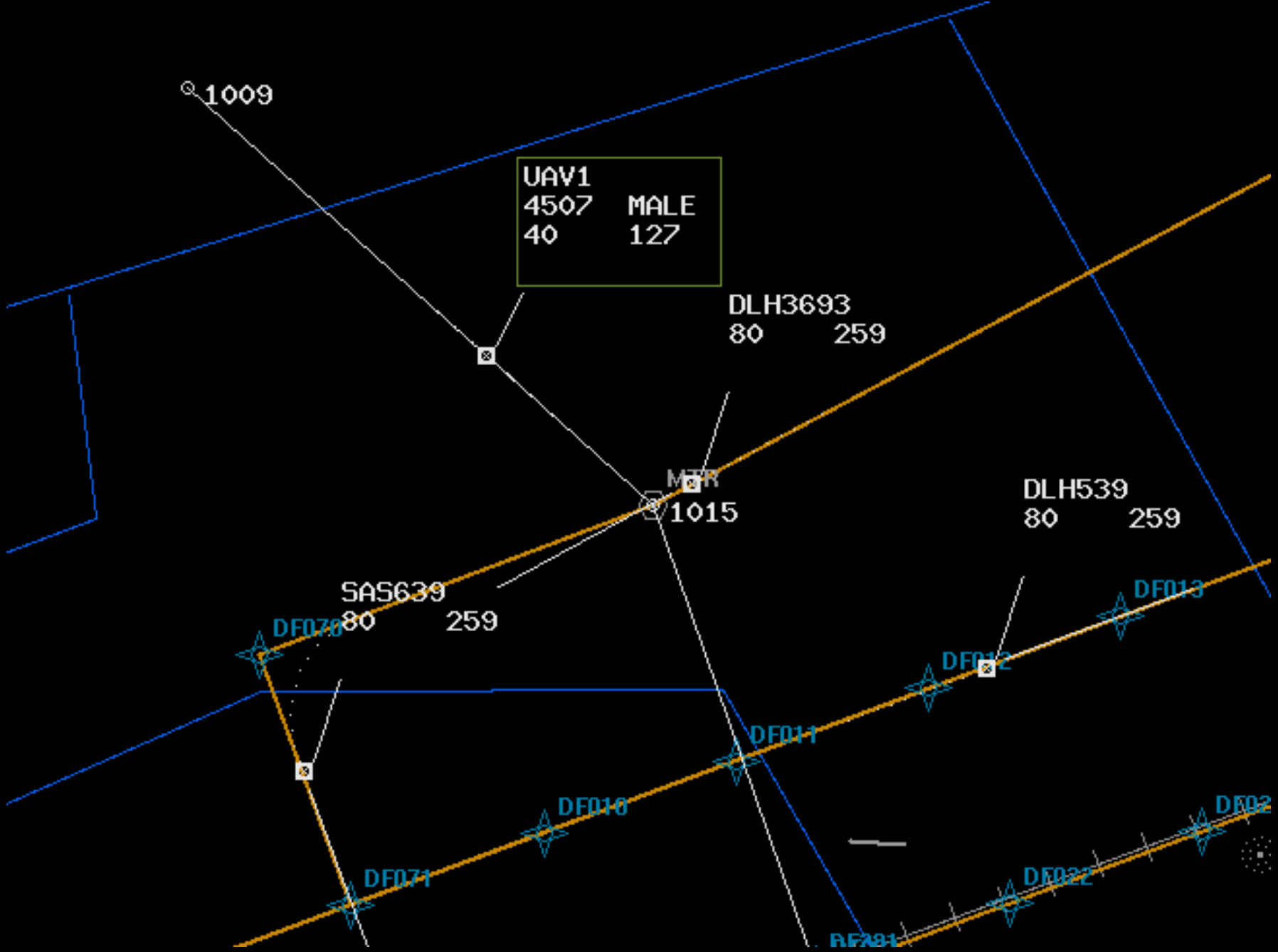
DF010

DF071

DF02

DF022

RF781





ABUMO

UAV81  
7700 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)

<u>Scenario No.</u>	1	
<u>Name</u>		usico_1_uav_ef
<u>Scenario Description</u>		Engine failure of an UAV
<u>UAV Mission Description</u>		tbd
<u>Simulation Area</u>		FIR Frankfurt
<u>Working Positions</u>		
<i>Controller Working Position</i>		
	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
<i>Pseudo Pilot Working Position</i>		
	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

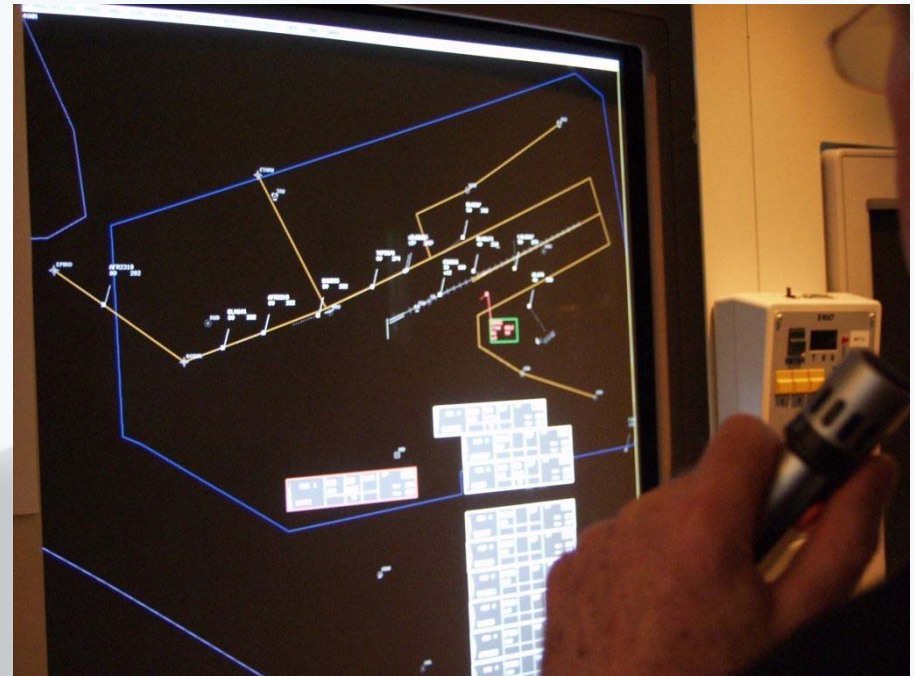
#### Weight Classes

H	30 %,
M	60 %,
L	10 %

#### Sectors

33 % West
33 % North
33 % South

Let's start

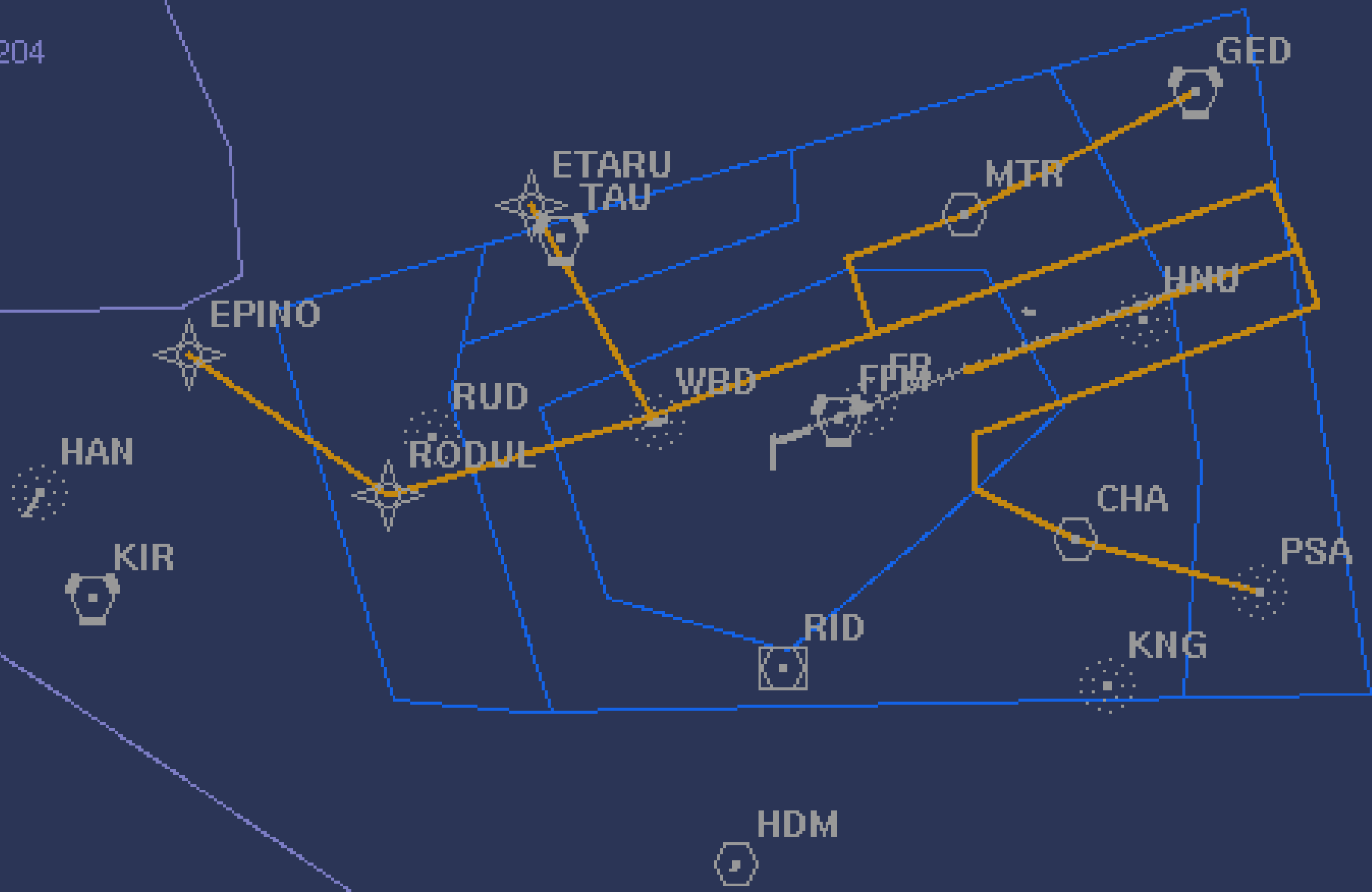








ED-R 204



ED-R 205



1783  
270

DLH4173  
40 266

HNU

ABUMO

SBI871  
21 192  
v10

RADCO  
LEDKI

IBE4516  
40 361

DLH3693  
7 137  
v11

EFM

BOMBI

RILUX

SOLTA

DONIS

CHA

1783  
270

DLH4173  
40 266

HNU

ABUMO

SBI871  
21 192  
v10

RADCO  
LEDKI

IBE4516  
40 361

DLH3693  
7 137  
v11

EFM

BOMBI

RILUX

SOLTA

DONIS

CHA

DLH459  
80 283

OAL333  
40 266

DLH4173  
40 266

BER9873  
32 237  
v10

BAW851  
4 137  
v9

DLH3693  
40 266

BOMBI

SOLTA

SBI871  
40 266

DLH459  
80 283

OAL333  
40 266

DLH4173  
40 266

BER9873  
32 237  
v10

BAW851  
4 137  
v9

DLH3693  
40 266

EPM

BOMBI

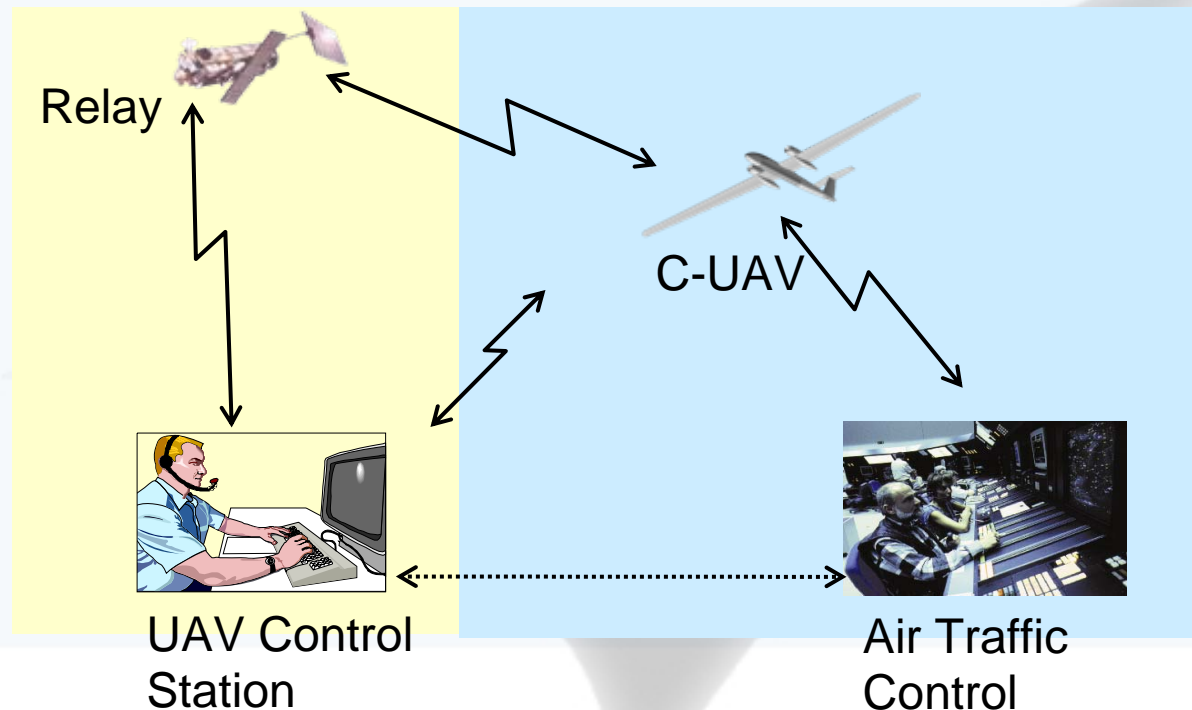
FILUX

SOLTA

SBI871  
40 266

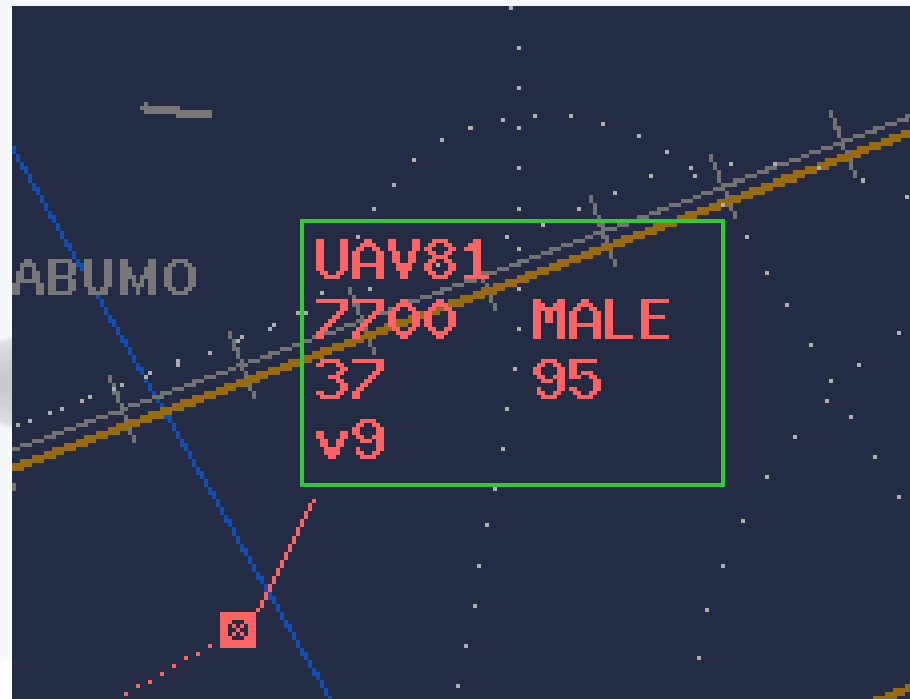
## First Results based on controllers' comments

- 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' comments (cont 2)

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

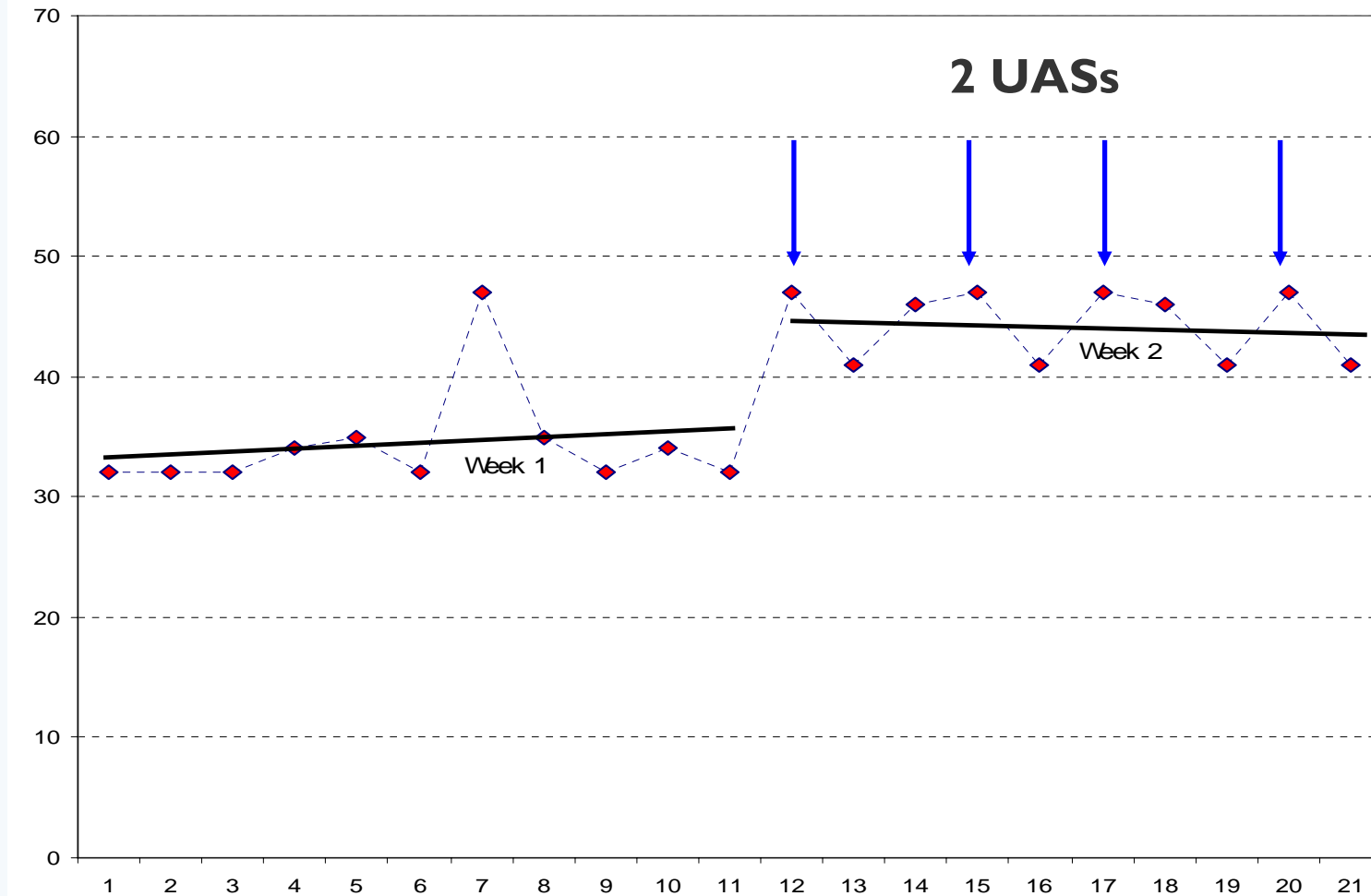


UAV Control Station



Air Traffic Control

## Workload of controllers





Vielen Dank für Ihre Aufmerksamkeit  
**Fragen ?**

