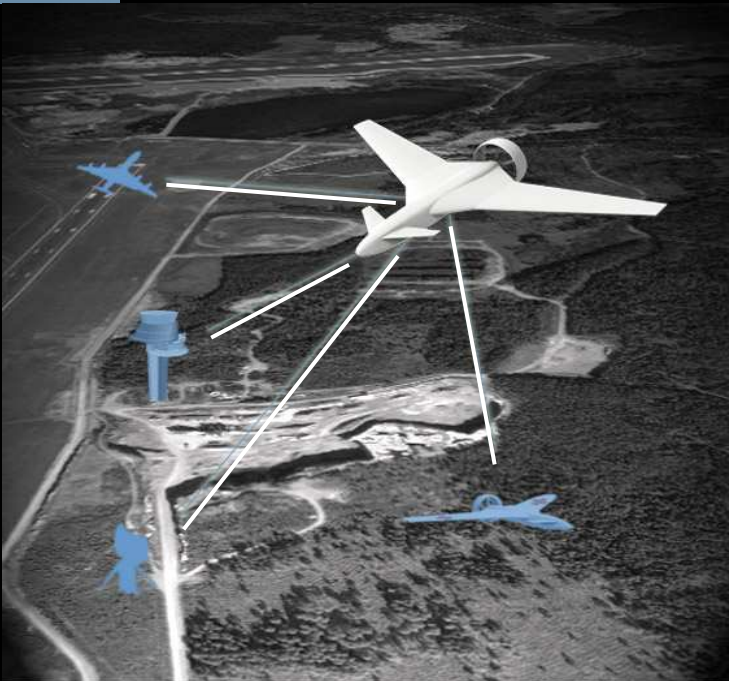




# Lessons from Designing Controller-Pilot Data Link Communication for UAVs



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Rikard Andersson

Håkan Ekström

# UAV System

Unmanned Air Vehicle



UCS – UAV Control Station



Sensor operator

UAV commander / pilot

# Operational Concept

- Operate a UAV in unrestricted civil airspace
- CPDLC (**C**ontroller-**P**ilot **D**ata **L**ink **C**ommunication) is the service enabling ATC to directly access the UAV system





Main Display - UAV commander

EM KV FM EM KV



### Flight Plan and Control

Flight State: Parked at gate

A01

Waypoint name:

SPD:  HDG:  ALT:

HLC:

Navigation:

Hold Position  Missed Approach  Arr.

Ground:  Brake to stop  Hold at WP

Active  Edit

Activate  Set cmd point

Flight Plan	SPD	HDG	ALT	Current
DEPARTURE AIRPORT				
TWY 11	10	216°	-	
HLD 1	10	036°	-	
TWY 11	10	216°	-	
HLD 1	10	036°	-	
TP2	10	040°	-	
TP3	10	065°	-	
Int 1	6	086°	-	
Line up 11	10	103°	-	
TOP 11	10	103°	-	
DEPARTURE				
THR 29	78	102°	600	
ALT 600 ft	78	102°	600	
EN-ROUTE				
SAP1	98	130°	4000	
SAP2	98	090°	4000	

Destination Airport:

Aerodrome:

ID:  Name:

Segments:  Add

### Status control

ENGINE:  COMPTN:  LINK:  CAUTION:

FUEL:  PRIMDAT:  COM:  MISSION:

GEAR:  ELSYS:  NAV:  S/A:

ENG:  NORM:  STATUS:  LOG:

Alerts:

### CPDLC Control

Request:

Altitude:

Climb to:

Police:  Arrivals:

Send

### ATC Calling

Request:

Altitude:

Climb to:

Police:  Arrivals:

Send

### Map

Elite Tools Settings Help

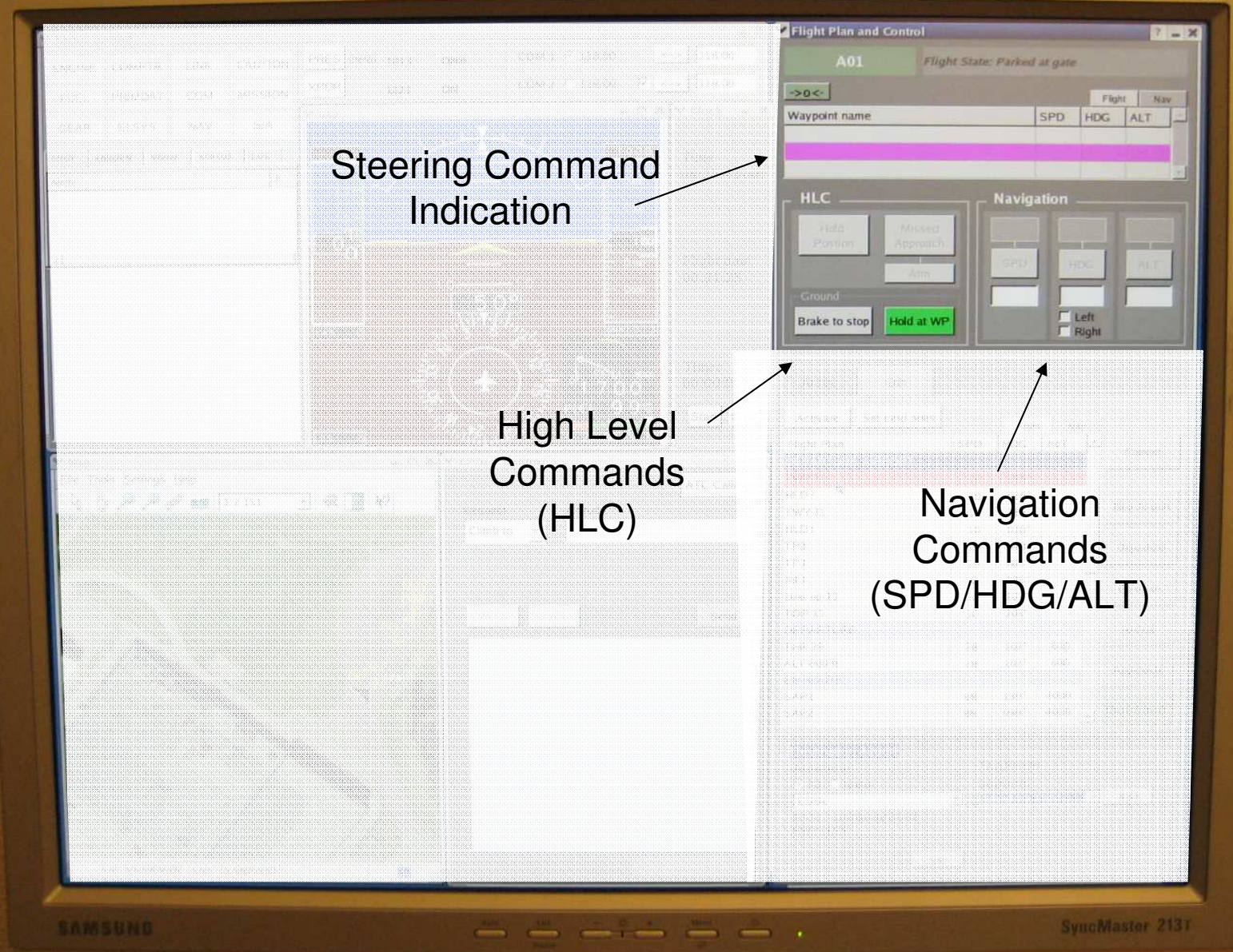
12.151

Lat: 58.4569002 Lon: 15.6895930

SyncMaster 2131

SAMSUNG

FM  
EM  
KV  
FM  
EM  
KV

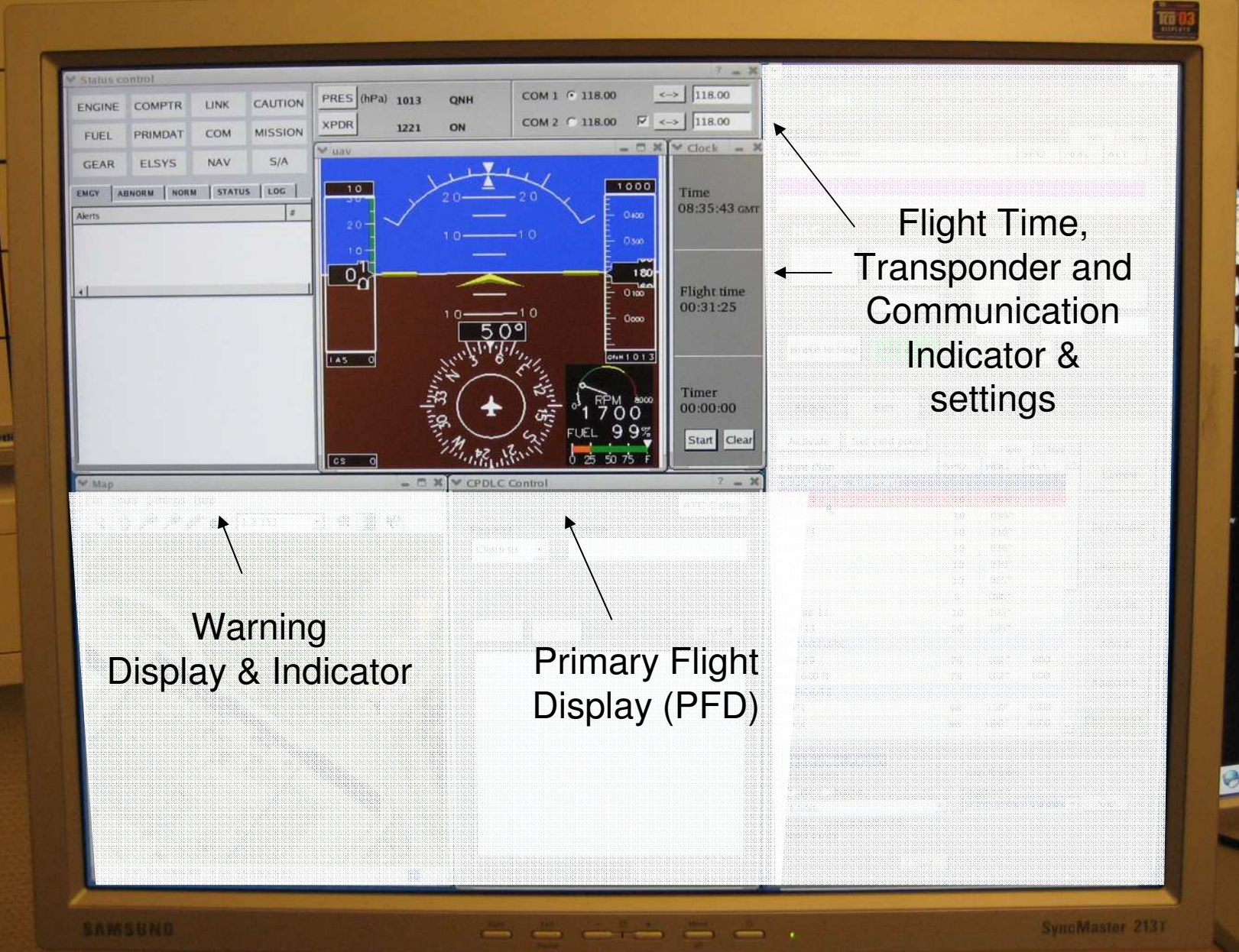


Steering Command Indication

High Level Commands (HLC)

Navigation Commands (SPD/HDG/ALT)

FM  
EM  
KV  
FM  
EM  
KV

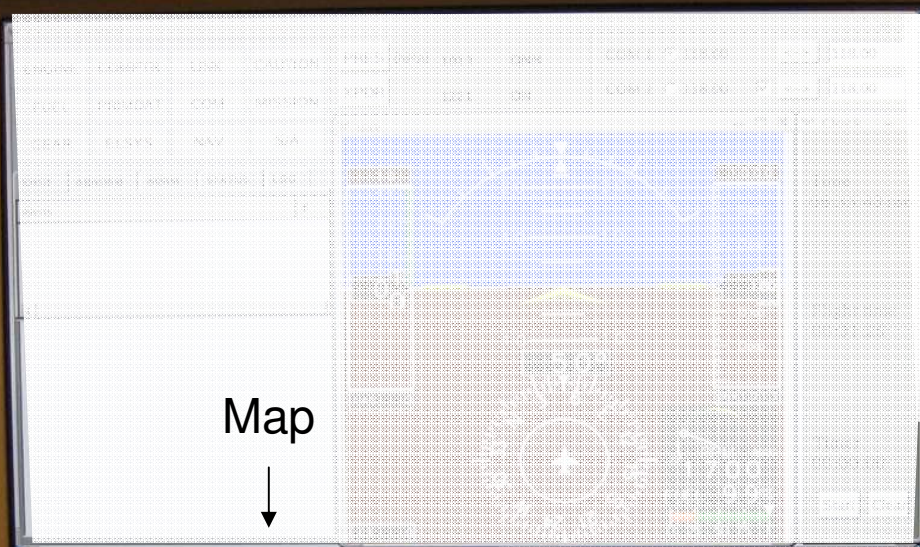


Warning  
Display & Indicator

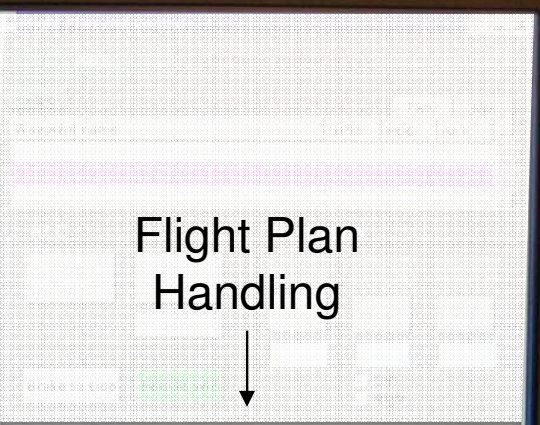
Primary Flight  
Display (PFD)

Flight Time,  
Transponder and  
Communication  
Indicator &  
settings

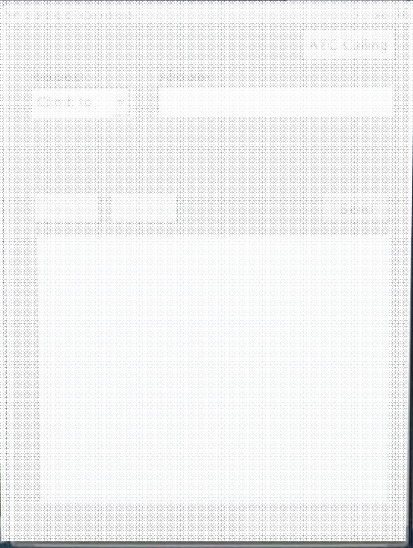
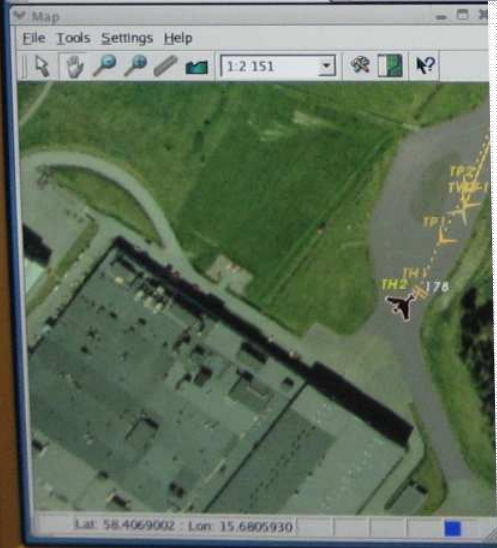
FM  
EM  
KV  
FM  
EM  
KV



Map



Flight Plan Handling



Active		Edit	
Activate	Set cmd point	Flight	Nav
<b>Flight Plan</b>			
<b>DEPARTURE AIRPORT</b>			
TWY 11	10	216°	-
HLD 1	10	036°	-
TWY 11	10	216°	-
HLD 1	10	036°	-
TP2	10	040°	-
TP3	10	065°	-
Int 1	6	086°	-
Line up 11	10	103°	-
TOP 11	10	103°	-
<b>DEPARTURE</b>			
THR 29	78	102°	600
ALT 600 ft	78	102°	600
<b>EN-ROUTE</b>			
SAP1	98	130°	4000
SAP2	98	090°	4000
<b>Destination Airport</b>			
Aerodrome		Taxi Routes	
<input type="radio"/> ID	<input type="radio"/> Name	Segments	
ESSL		Stand via TWY 1	
ESSL - Linköping/SAAB RWY11/29		Add	
Set			

SAMSUNG

SyncMaster 2131

FM  
EM  
KV  
FM  
EM  
KV

TO  
TB 03  
03/04/12

```
CPDLC Control
Request: Climb to
Altitude:
[Buttons: Cancel, Enable, Send, ATC Calling]
```

CPDLC

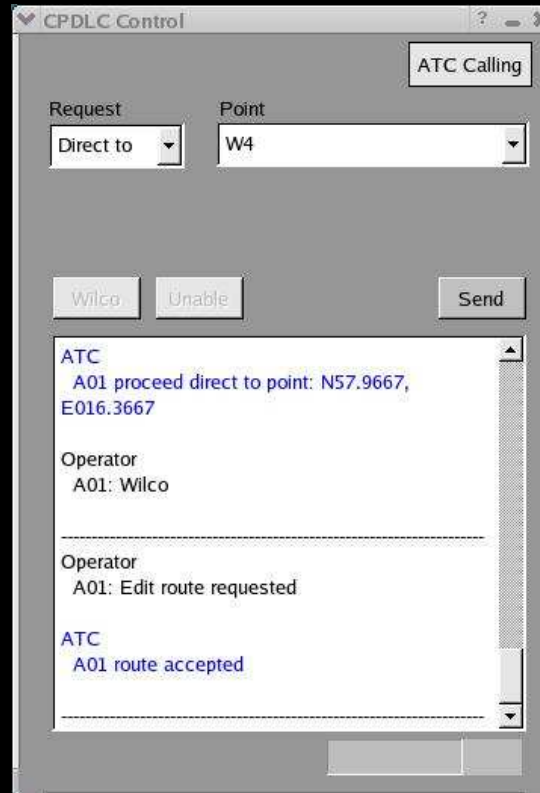


SAMSUNG

SyncMaster 2131

# Usability Requirements

Efficiency →

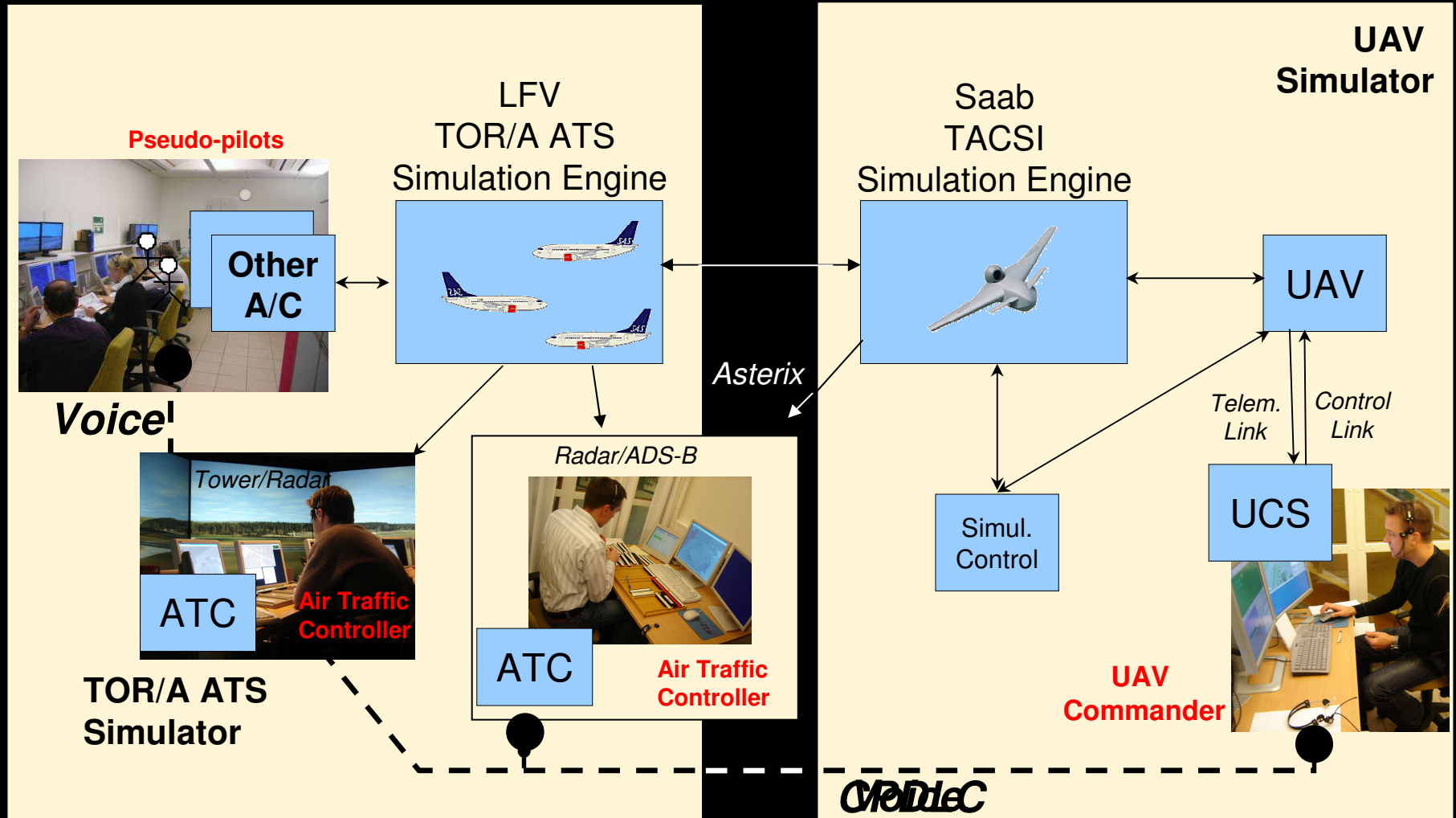


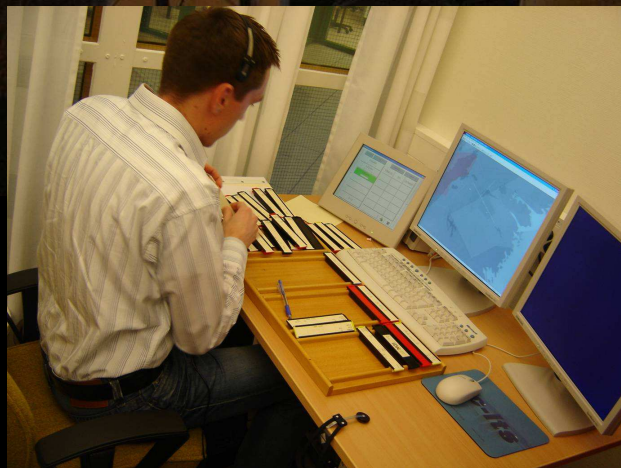
← Notifying

← Traceable

← Feedback

# General Architecture





APP Radar Controller



UAV Operator

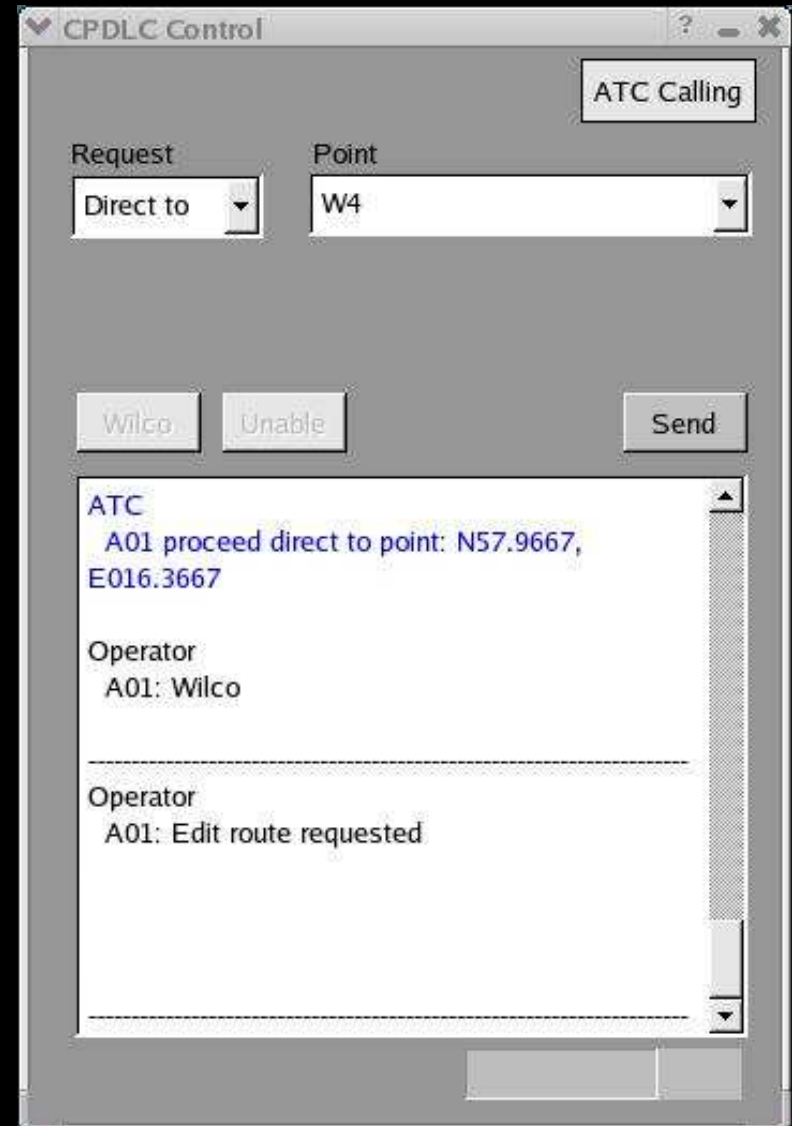


ESSL Tower Controller



# Point-to-Point

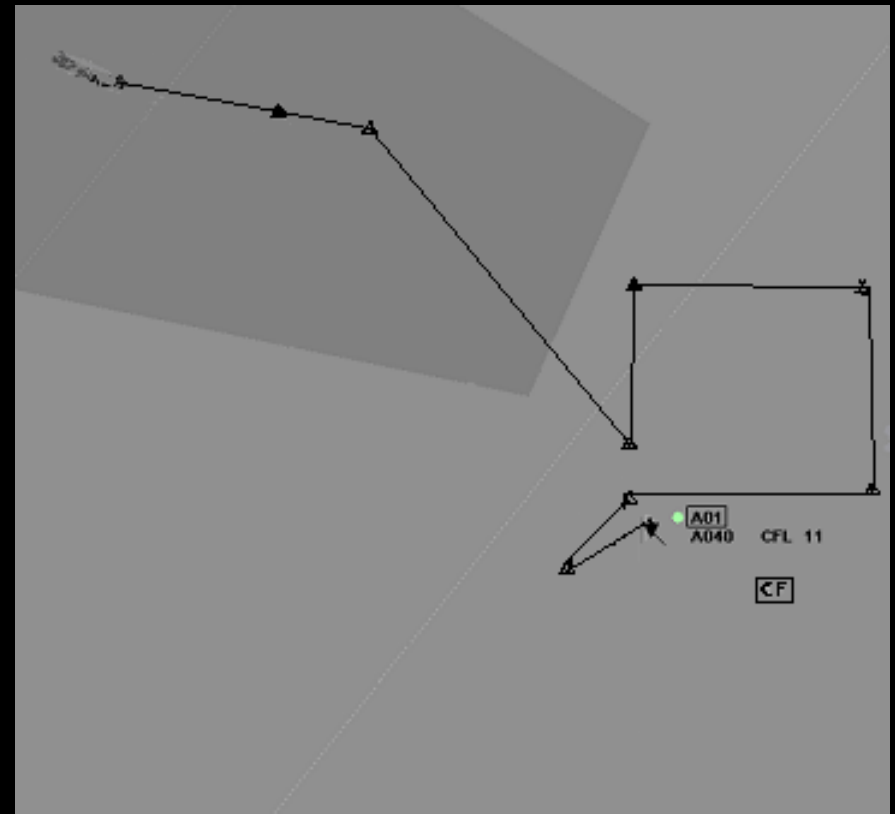
UAV-commander requests a new route including a search pattern





# Point-to-Point

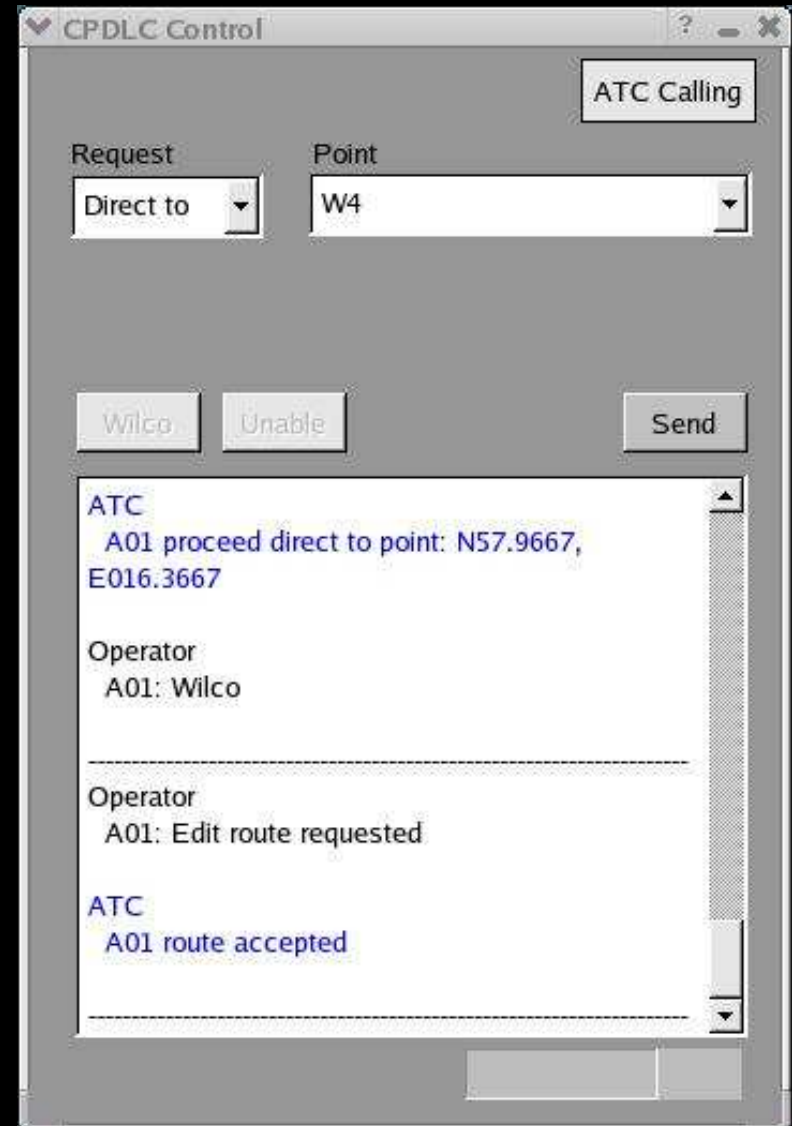
UAV-commander requests a new route including a search pattern





# Point-to-Point

UAV-commander requests a new route including a search pattern





# Future

More simulations to test the concept and investigate the benefits



Questions .....