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## UAS Integration Starts Now

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*AT-One is the ATM Alliance between NLR and DLR*

# Motivation and problem description

- **UAS are becoming more and more in use in the military world**
- **In civil world: a lot of interest**
- **Now, they are restricted to fly**
  - limited locations
  - permission to fly on case-by-case basis
  - segregated airspace
- **Our goal is to fly the aircraft anywhere**
  - VFR, IFR
  - file-to-fly
  - controlled and non-controlled airspace (class A to G)



## Means to achieve the goal

- **Perform simulations with air traffic controllers**
  - to gain awareness with controllers of UAS issues
  - to learn what are the issues
- **To set up realistic scenarios in realistic environments**
  - normal operation in other traffic
  - emergency situations
- **We restrict to IFR and controlled airspace**
- **Two projects: SINUE and USICO**
  - international context – ensure acceptance
  - work in consortia

# Research questions

1. What architecture do we need
2. What procedures do we need
3. What emergency procedures do we need

Experience from air traffic controllers  
is crucial



# Assumptions

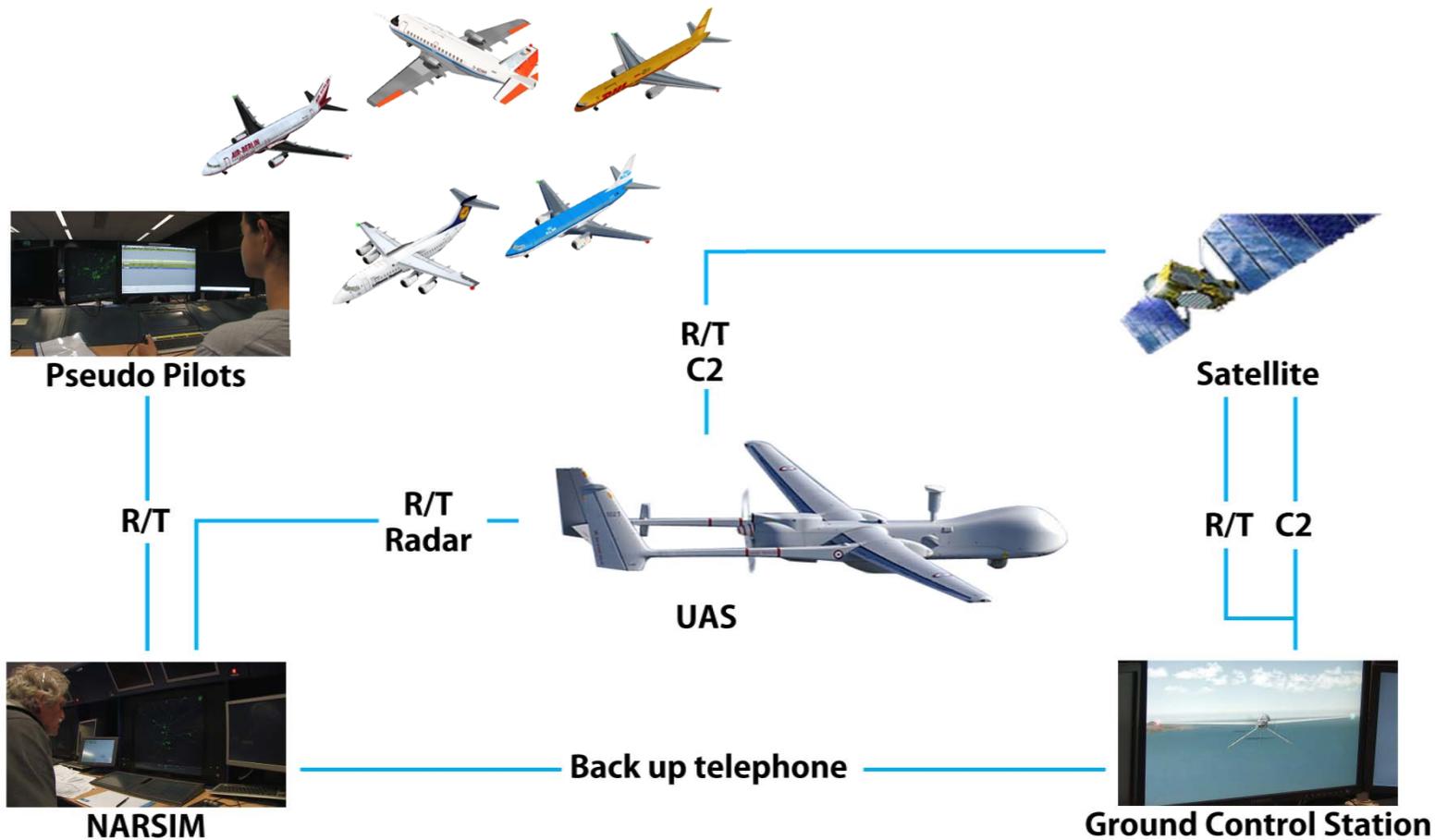
- Stay close to current day scenario for ATC
- Stay close to current day scenario for controlling the UAS (no autonomous flight)
- In an ATC environment means beyond visual line of sight. We will even assume BLOS (not only RLOS).
- Integration in traffic scenarios – existing scenarios can be used with insertion of one (or more) UAS



# 1<sup>st</sup> question: architecture

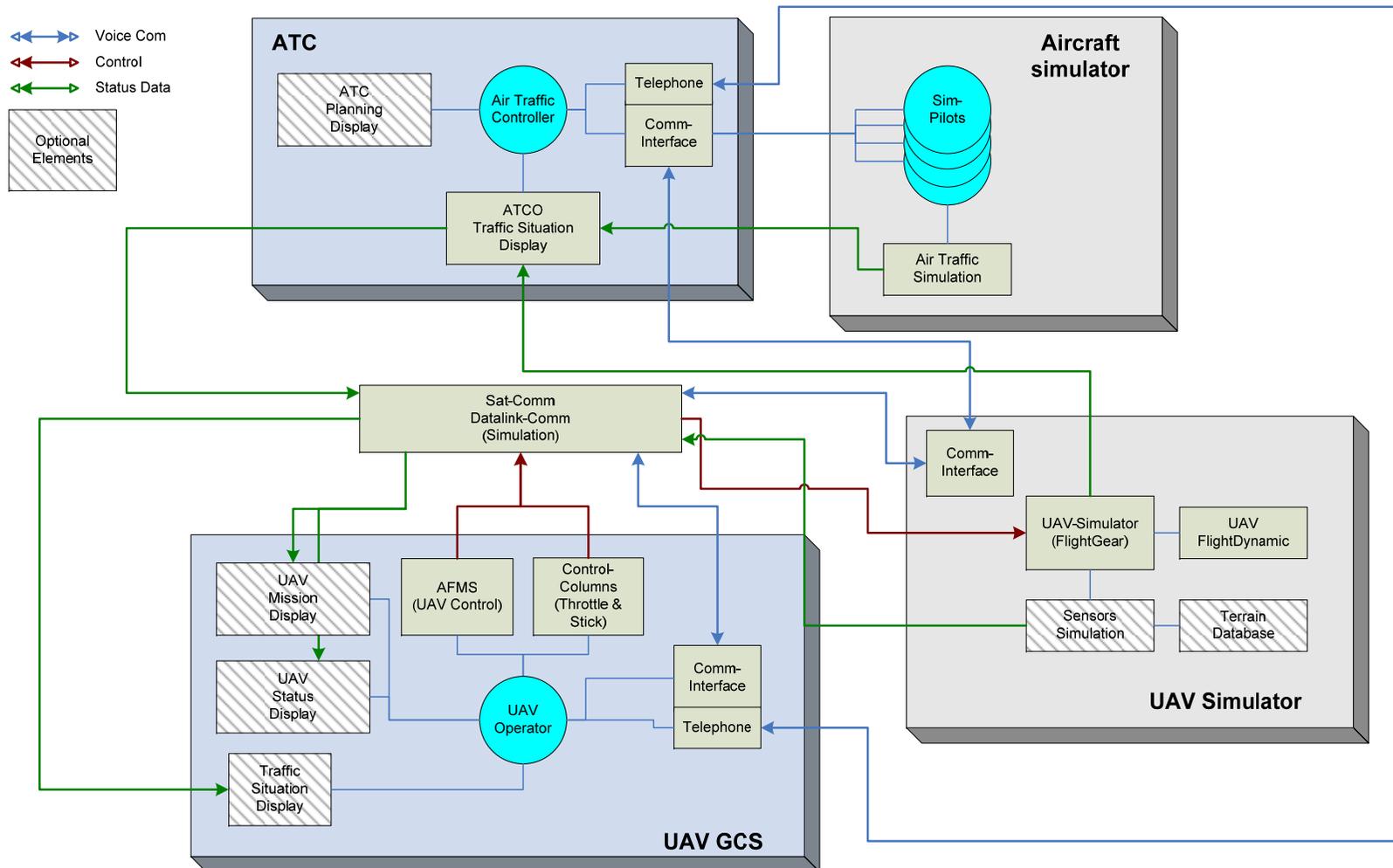
- **Many working groups are involved in setting up the necessary architecture (e.g. WG73)**
- **Main questions involve**
  - with an UAS, the pilot cannot look out of his window: DAA
  - no “feel” the vibration of the aircraft
  - no awareness of where to land/crash in case of emergency
  - how to use the available infrastructure, not only through communication via the aircraft, but also to use land infrastructure
- **Ground based pilot is not always a disadvantage: the pilot is able to communicate with ATC over a land line**
- **Considerations:**
  - adaptation of existing (ATC) systems
  - necessary on-board equipment (weight and sensitivity)
  - Line of Sight (VHF) vs. Beyond Line of Sight (SatCom)

# Architecture used in the simulation



**SINUE communication overview**

# Communication structure



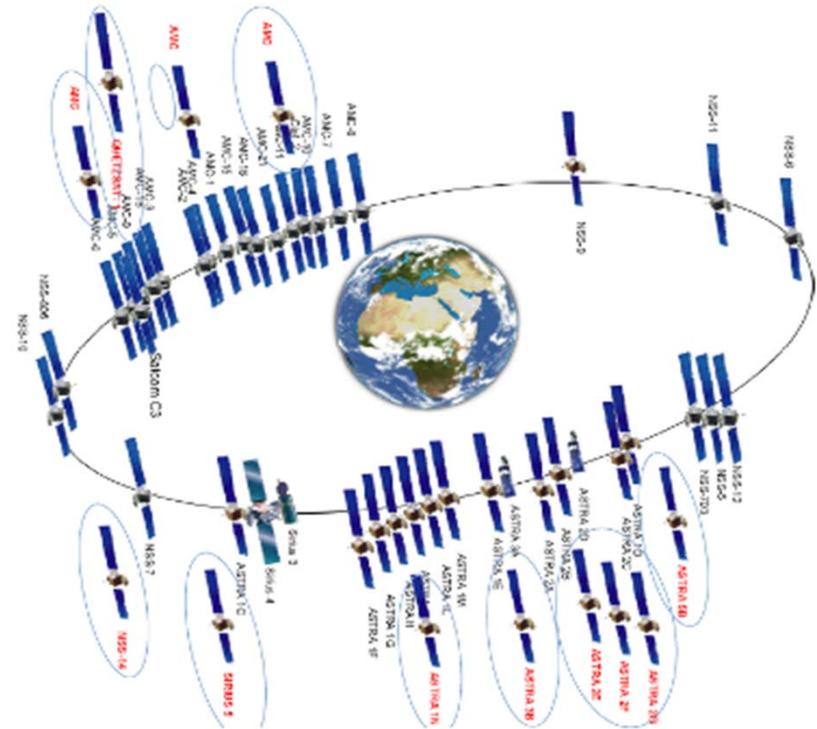
## 2<sup>nd</sup> question: procedures

- **Special procedures for UAS could be developed**
- **Considerations**
  - use of special routes
  - special call signs
  - special transponder codes
  - special symbology on ATC display
- **One may wonder how much “integration” is taking place in these situations**
- **As our aim is to integrate UAS in traffic, we decided to have the unmanned aircraft act like other aircraft**
  - only a dedicated call sign was used
  - special transponder codes were use for emergency situations

# 3<sup>rd</sup> question: emergency situations

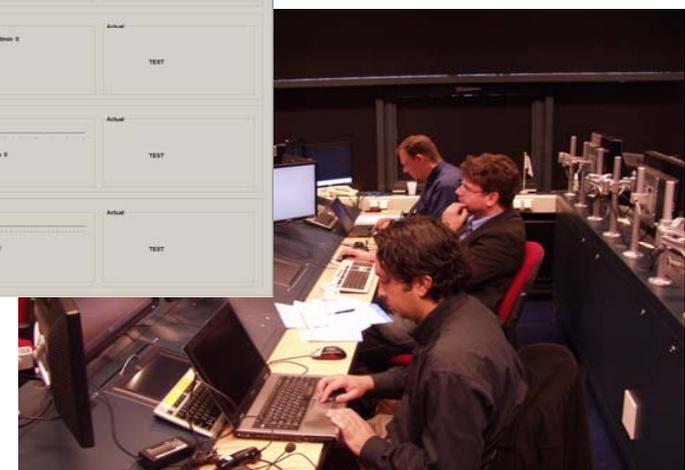
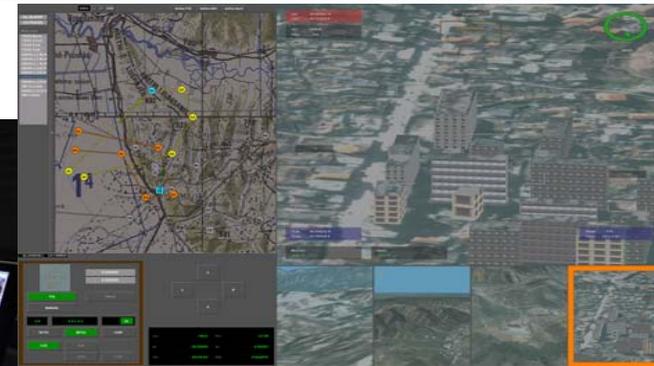
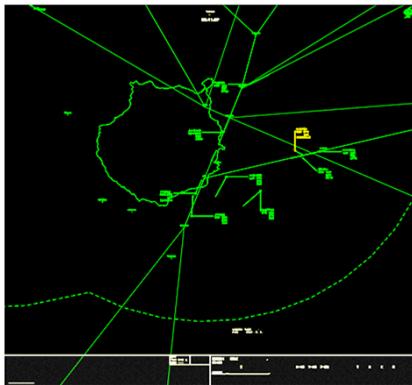
## EASA Impact Assessment on Safety of Communications

- Loss of voice communications between UAS pilot and ATC
- Interruptions to voice communications between UAS pilot and ATC
- Intelligibility and latency of voice communications between UAS pilot and ATC
- Loss of command and control link between UAS and GCS
- Interruption of command and control link between UAS and ATC
- Loss of surveillance information feed to ATC
- Interruption of surveillance information feed to ATC



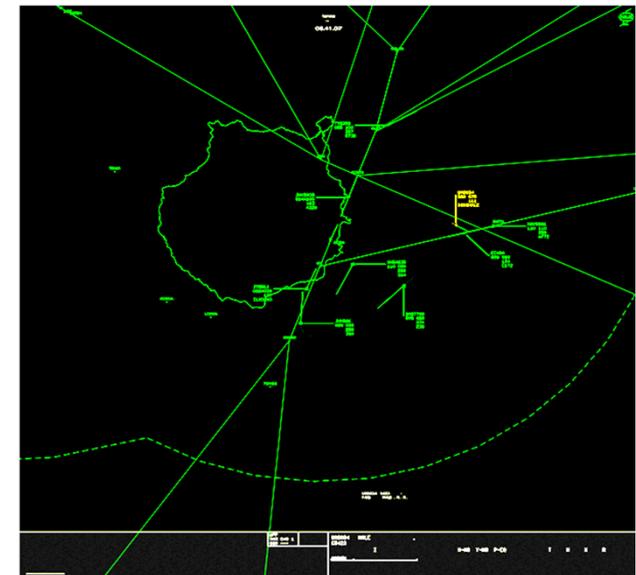


# Experience from air traffic controllers



# Human factors validation

- **ATCo**
  - callsign labelling of the UAS on the air traffic display
  - use of special emergency transponder codes
  - UAS flight performance
  - Workload
- **Communication with UAS pilot**
  - what to do in emergency situations
  - time delay in satellite communication
  - back up phone protocol
- **Two experiments**
  - Frankfurt area (USICO project)
  - Canary Islands area (SINUE project)



# Means of verification

- Check the number of conflicts
- Questionnaire after each run
- Questionnaire at the end of the day
- Discussion session with
  - air traffic controller
  - UAS pilot
  - pilot that controlled the other traffic
  - route designers
  - experiment supervisor

# Results

- **No need for further specialising SSR codes:**

- 7600: comm loss
- 7660: datalink loss, proceed as planned
- 7661: datalink loss, return home
- 7662: datalink loss, fly to emergency field
- 7700: emergency

- **Fly home-procedure must be consistent with emergency procedures for manned aircraft**

- indication of call sign (SSR code)
- special go-around procedure on final approach
- normal route diversion procedure (two minutes straight flight and then climb/descent towards the emergency route)

- **Use of the phone for backup communication is appreciated**

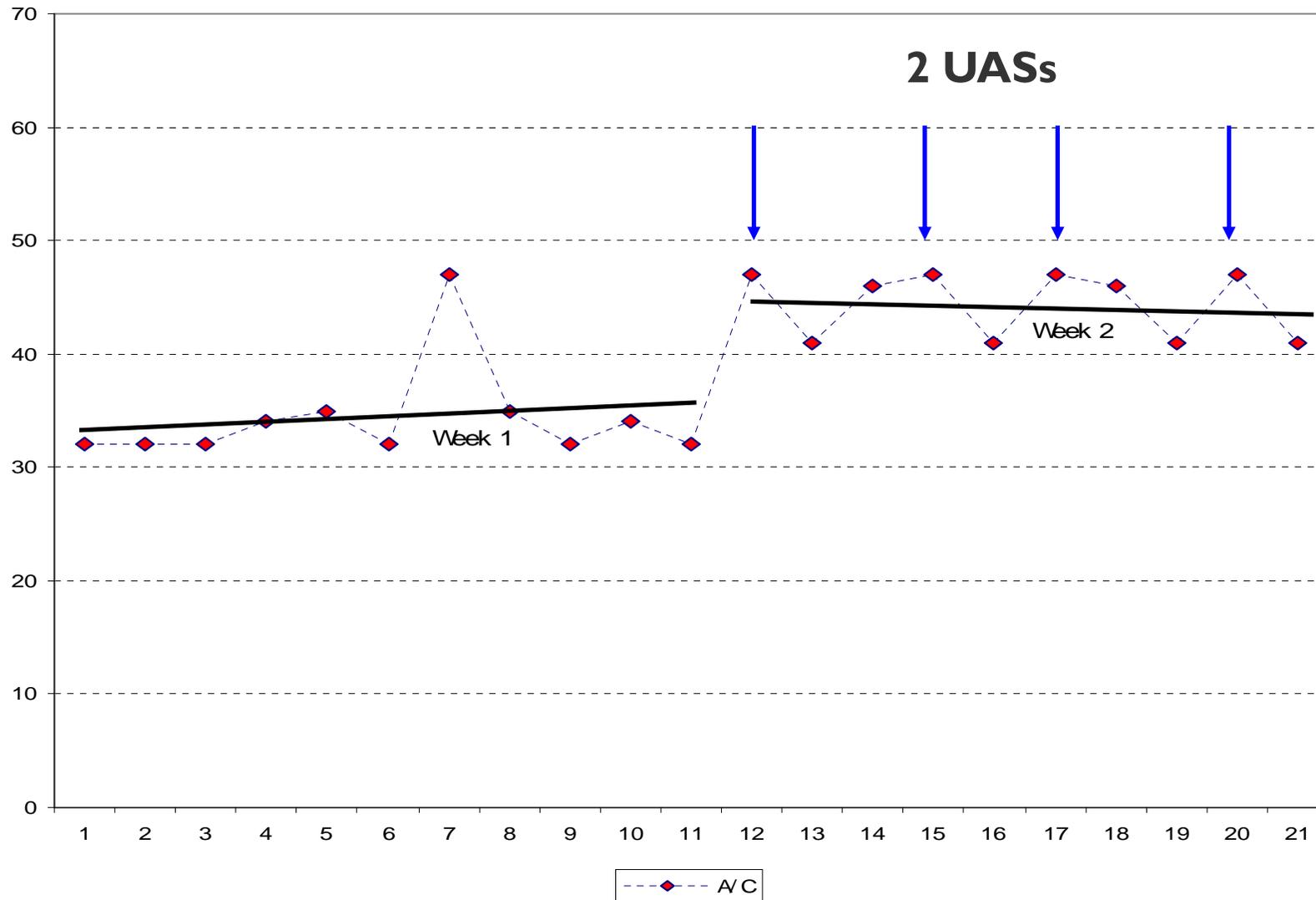
- remote pilot must initiate the call
- initially contacts ATC supervisor

## Conclusions: UAS air traffic insertion

- We performed real time ATC simulations to prepare for real integration of UAS in the air traffic
- Show to controllers in each case how it will work, through real time simulation the safety case on procedures and emergency situations can be supported
- Design emergency procedures is necessary in consultation with ATC
- We have demonstrated the possibility!

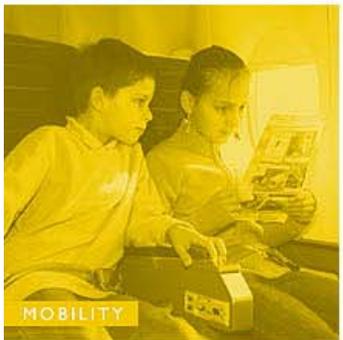
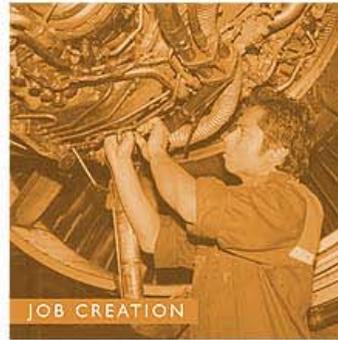


# Workload of Controllers (USICO project)





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