

# Common Trajectory Coordination A Concept for Future ATM

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## Common Trajectory Coordination A Concept for Future ATM

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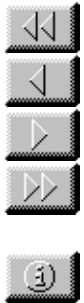


Presented by Karlheinz Jünemann  
Dept. FRA OYT Technical Standards, Flight Operations

Common Trajectory Coordination - A Concept for Future ATM  
ATM R&D Seminar, Saclay 14.-18.06.1997 - Chart 1



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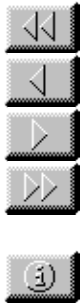
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## Airborne Separation Integral Part of Future Air Traffic Management

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- Current Air Traffic Management System is challenged by future capacity demands.
- Bottlenecks are runway capacity and controller workload.
  - Sector capacity limited by number of aircraft that can be handled by one controller.
  - Creation of additional sectors is limited by minimum feasible size of sectors.
  - Increase the number of aircraft per controller by reducing his workload freeing him from separation responsibility.
- Airborne separation control is needed for future Air Traffic Management.
  - Compatible with Air Navigation Service
  - Integration and communication standards are to be defined.



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## Air Traffic System Complexity

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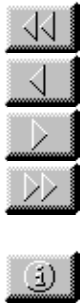
- The ATM System has to serve multiple demands from:
  - Air Traffic Service
  - Airline Dispatch
  - the Cockpit
- No partner has an optimum solution for the complete system
- Optimum can be reached, if all partners apply the method of structured negotiation:
  - find the common interest
  - negotiate the rest

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## Air Traffic System Partners and Areas of Interest

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The diagram illustrates the components of an Air Traffic System and their shared areas of interest. On the left, three vertically stacked circles represent different entities: a white circle for 'Cockpit', a grey circle for 'ATLD ispatch', and a black circle for 'Air Traffic Service'. To the right, a large circular graphic is composed of three concentric rings: an outer white ring, a middle grey ring, and an inner black ring. The text 'Common Interest' is centered within this graphic, indicating the overlapping areas of concern for all three entities.

Cockpit


ATLD ispatch

Air Traffic Service

Common Interest

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## Structured Negotiation

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- Structured negotiation is required within and between  
**Air Traffic Services - Cockpits - Dispatch**
- To support this negotiation it is required  
to have a complete understanding of each others **intent**.
- It also requires  
a common, precise and direct useable "**language**".
- In the technical solution both requirements are fulfilled  
by using the **trajectory** as the basic information.

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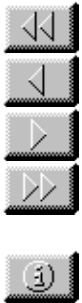
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## Trajectory

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- All planning and control functions have an impact on the aircraft's **trajectory**
- The trajectory is the net result of all control inputs
- Only one trajectory can exist for each aircraft
- Therefore the negotiation shall be based on the trajectory to avoid errors from misinterpretation



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## Flightplan versus Trajectory

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A clear differentiation between flightplan and trajectory has to be given:

- **Flightplan**

- A flightplan is defined as a 2D route description
- It covers the complete route between origin or present position to destination and alternate
- All route defining waypoints shall be communicated in LAT/LONG, independent of the way they have been defined by the pilot, controller or dispatcher
- A flightplan can also be used as an ad hoc „airway“, opened for this particular flight and be used as a reference (spatial orientation)
- It shall be processed independently from the trajectory

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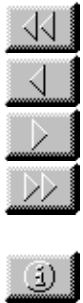
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## Flightplan versus Trajectory

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- **Trajectory**

- A trajectory is the 4-dimensional intended path description
- It describes the 4D path from present position to the active destination, if not limited by tbd. trajectory points or tbd. time (DB default or as requested by an uplink)
- It is defined by the waypoints that allow linear interpolation of any point in between



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## Flightplan versus Trajectory

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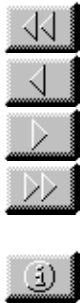
- **Trajectory** (cont.)
  - All trajectory points shall be communicated in LAT/LONG, ALTITUDE, TIME and ATTRIBUTE independent of the way they have been defined by the pilot, controller, dispatcher or system(s)
  - The trajectory is easy to understand
  - It is precise and does not require interpretation
  - It allows very much improved HMI

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## Common Trajectory Coordination (CTC)

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- The same trajectory (Common) shall be used in a negotiation between air/air, air/ground and ground/ground
- Trajectory determination and communication will be a natural result of the normal pilot and controller work routine
- Communication will be no more a task in itself
- **CTC will be the backbone of the new ATM system**

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## Data and Voice Communication

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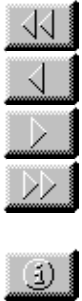
Common Trajectory Coordination is intended for automatic data communication

During the transition to the new ATM System it must be possible

- to communicate a flightplan and/or trajectory by voice

Therefore a naming convention is required

- to transform LAT/LONG automatically in an unambiguous five or seven character (alpha/numeric) name

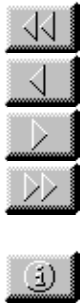


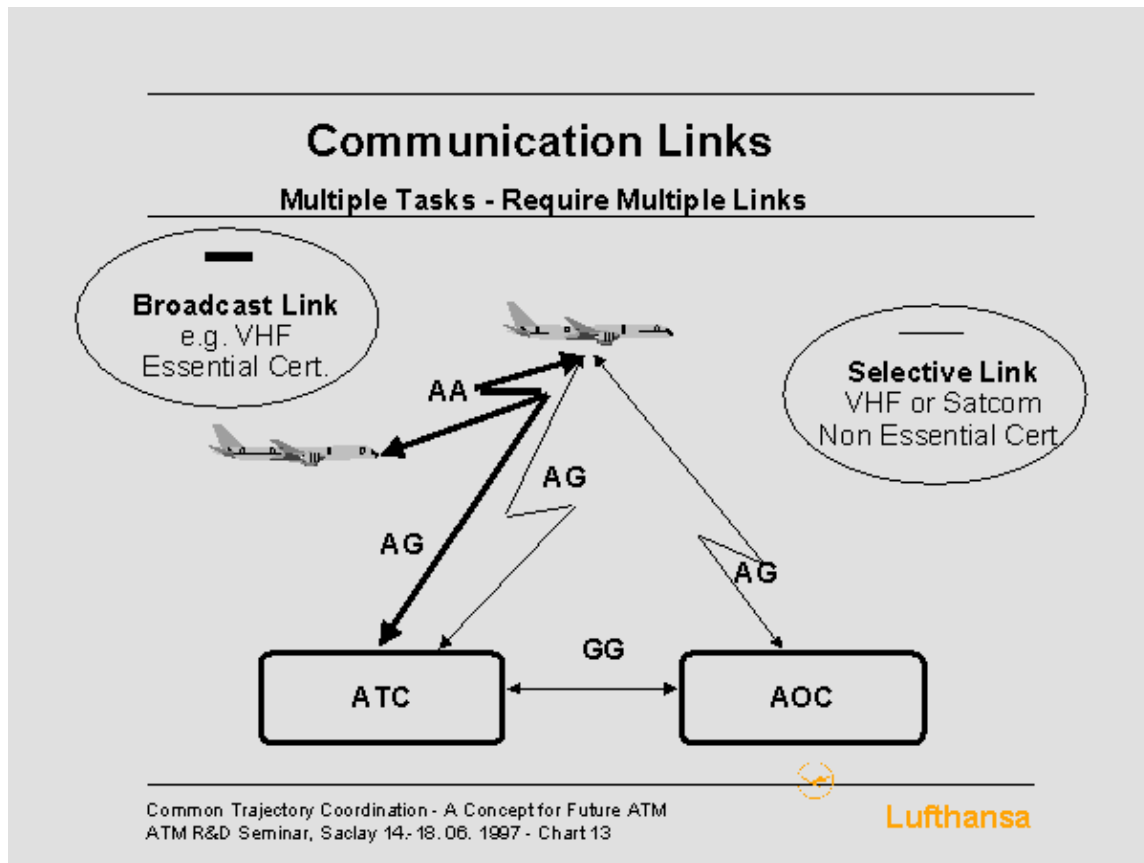
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## Impact of Common Trajectory Coordination on ADS-B

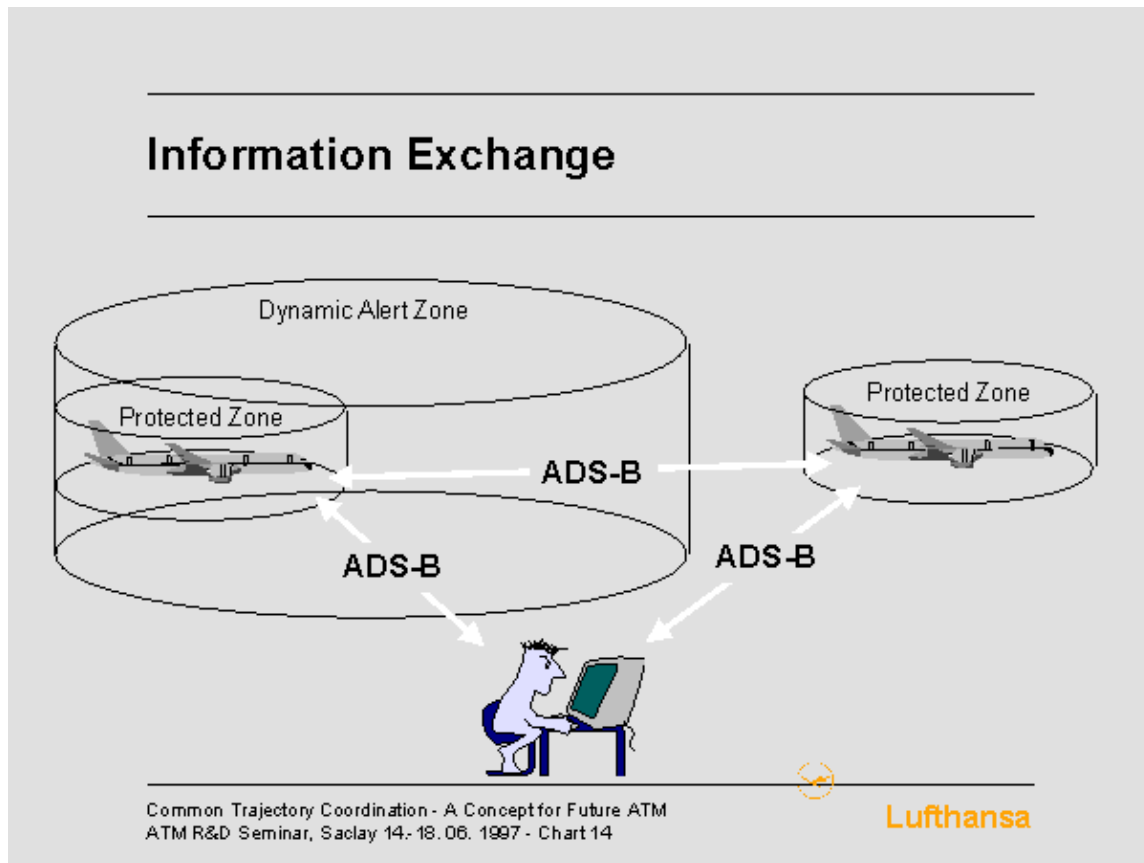
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- Common Trajectory Coordination has to be on a "PUBLIC BUS", available to everybody in the system, to increase AT-System redundancy
- ADS-B has to be expanded to include the trajectory
- Trajectory reports will reduce report frequency
- Replacing short, frequent messages with longer, less frequent messages reduces the overhead and the channel load

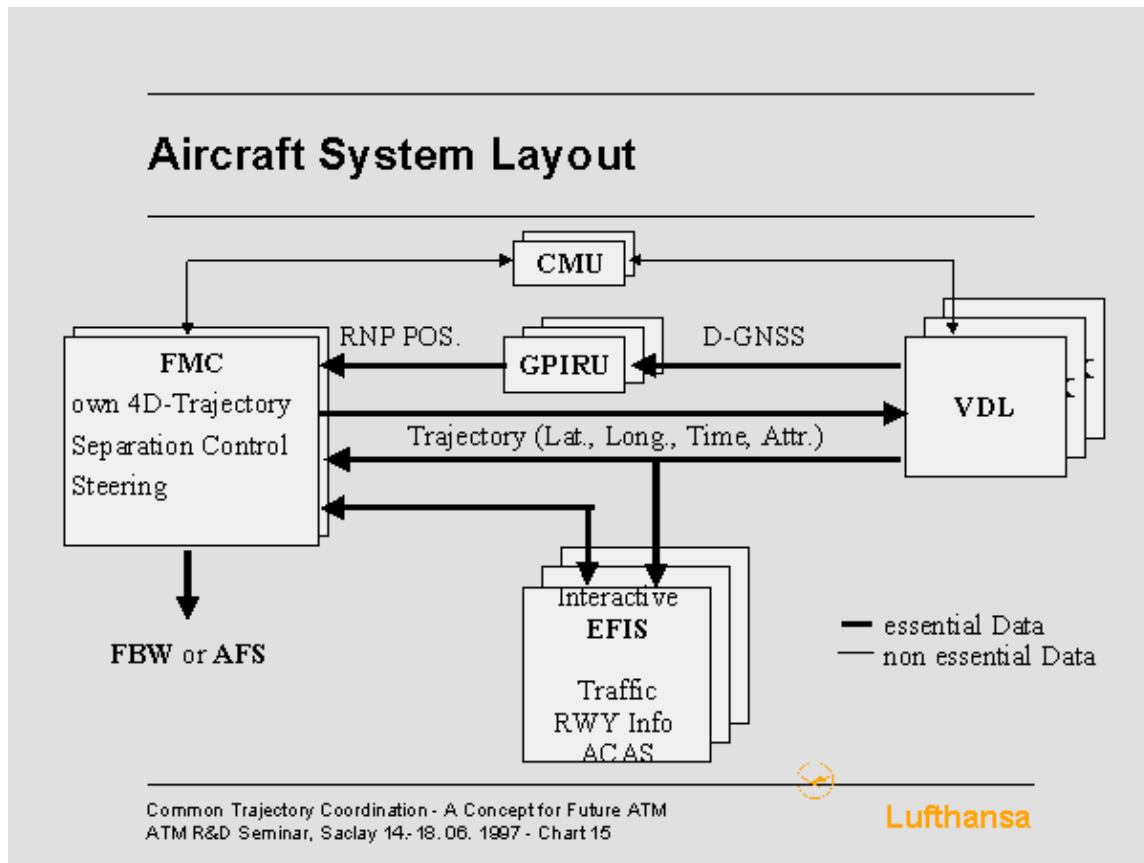




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## Aircraft Path Control Modes

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A new control mode is required for the autoflight system:

- 2D Mode:
  - lateral path is controlled as required by RNP
  - altitude and time is free
- New 4D Mode:
  - lateral path is controlled as required by RNP
  - altitude and time are controlled as predicted and broadcasted for „Common Trajectory Negotiation“

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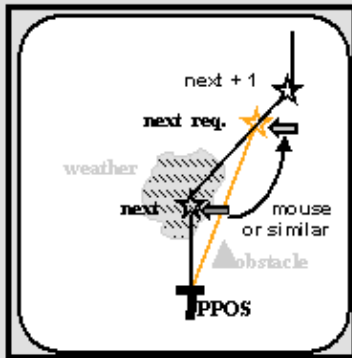


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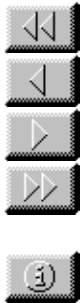
## Common Trajectory Coordination with improved HMI



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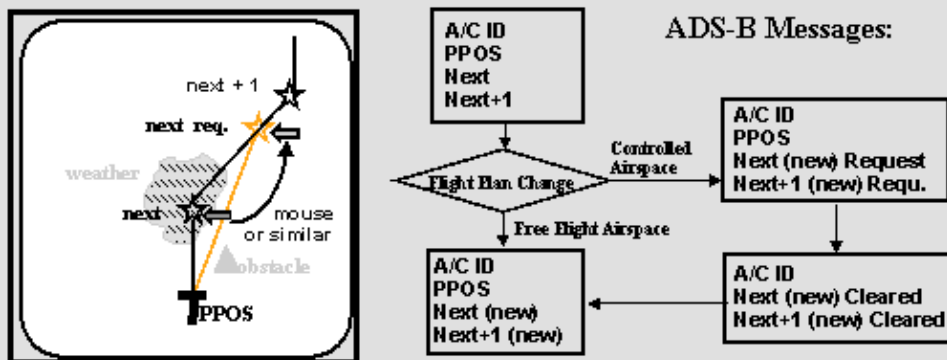
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## Common Trajectory Coordination with improved HMI

### Example: Negotiation for Flight Plan Change



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## Summary

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- **Structured negotiation between partners and areas of interest**
- **Trajectory as the common language**
- **Linear interpolation between 4D trajectory points with LAT/LONG, ALT, Time, Attrib.**
- **Common Trajectory Coordination**
- **Separation Control by Flight Management Computer**
- **Improved HMI and reduced Workload**
- **CTC as Backbone for future ATM**



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