

Controller Support for Time-Based Surface Management

First results from a feasibility workshop

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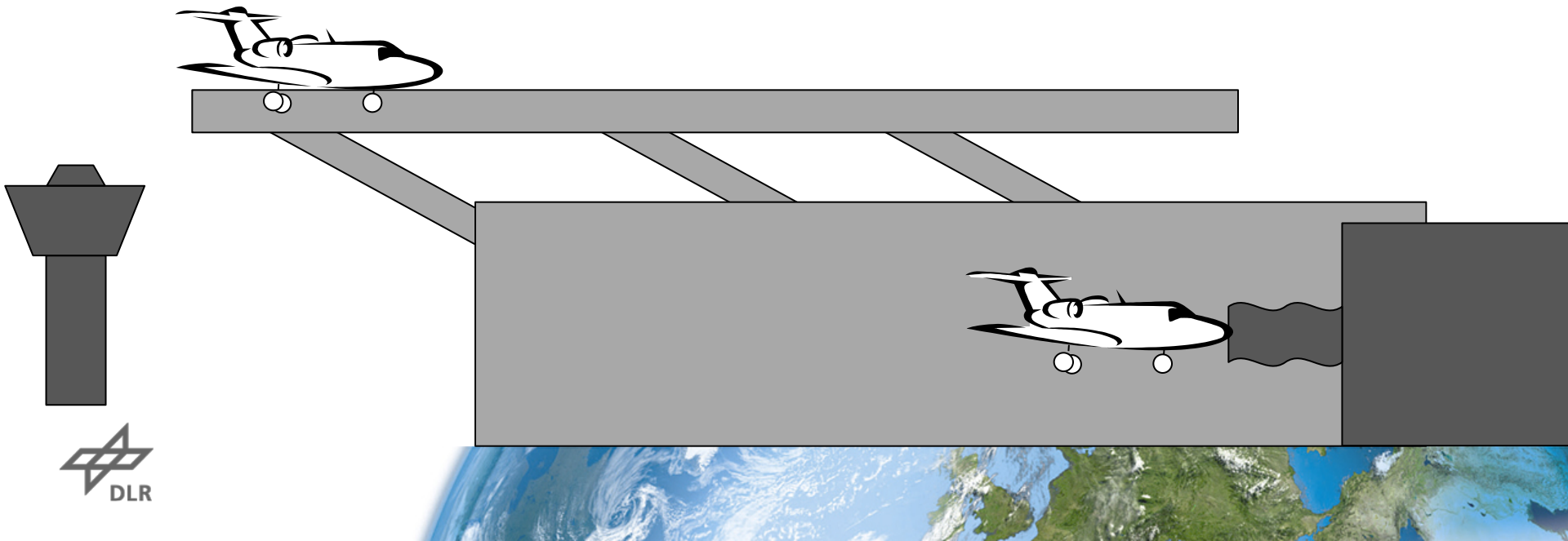
Knowledge for Tomorrow



Motivation – Trajectories

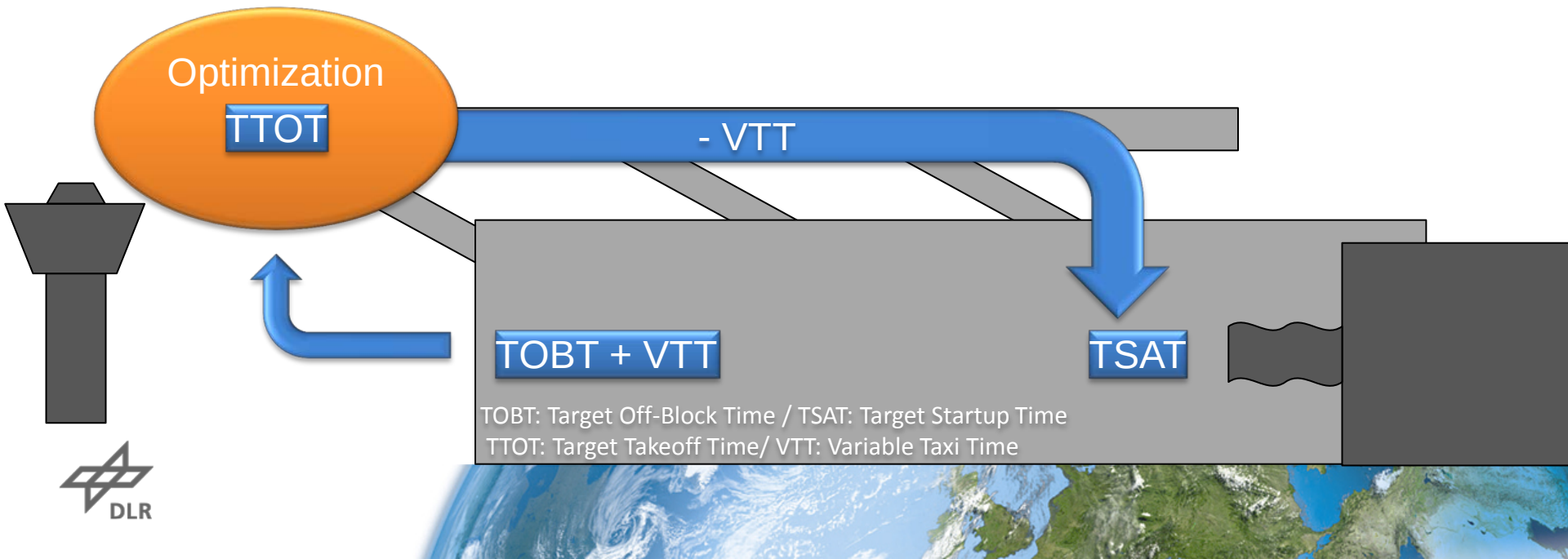
“the description of movement
of an aircraft both in the air and on the ground
including position, time, and at least via calculation,
speed and acceleration.”

Source: The SESAR Integrated Dictionary



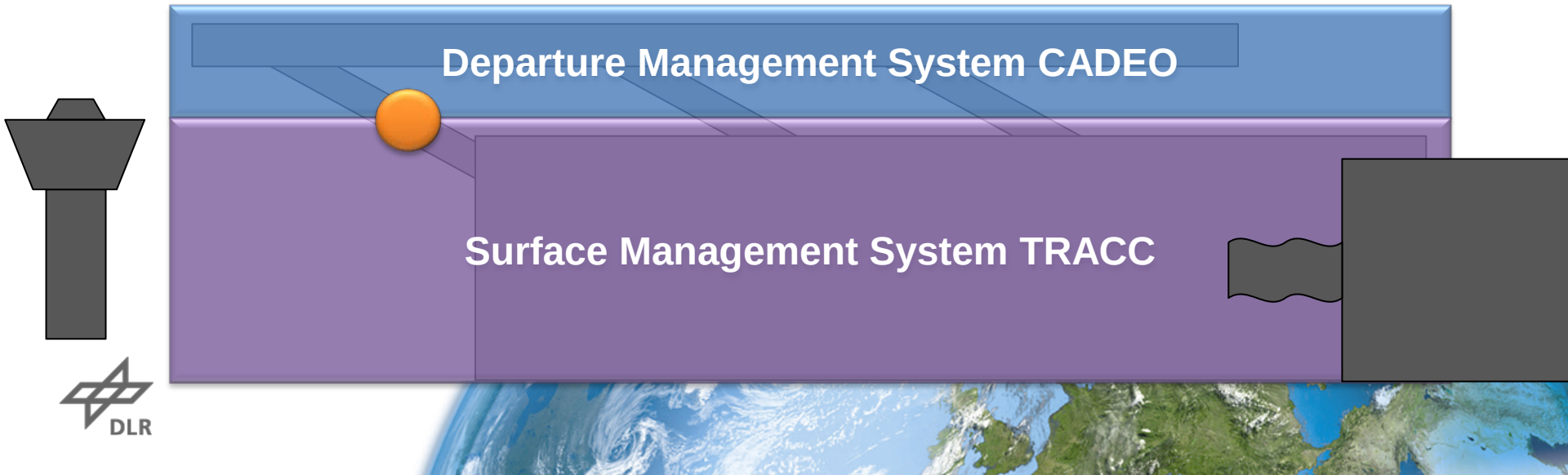
CADEO: Controller Assistance for Departure Optimization

- DLR's Departure Management System (DMAN) prototype
- Implements concept „Departure Sequence Optimization“



CADEO: Controller Assistance for Departure Optimization

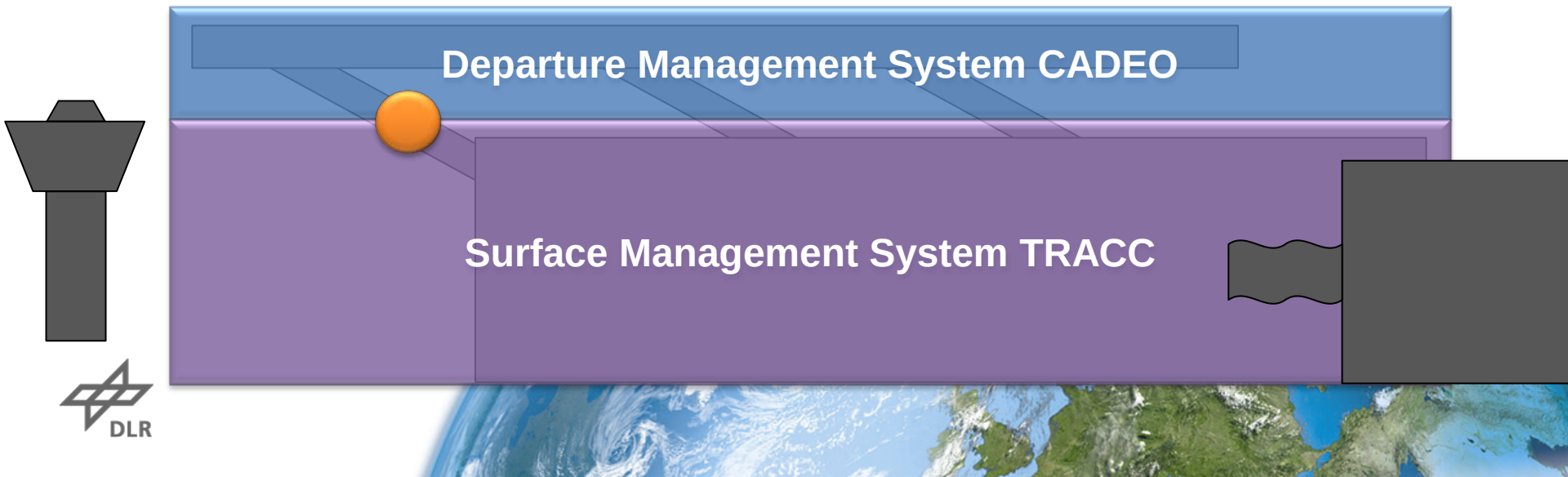
- DLR's Departure Management System (DMAN) prototype
- Implements concept „Departure Sequence Optimization“



TRACC:

Taxi Routing for Aircraft: Creation and Controlling

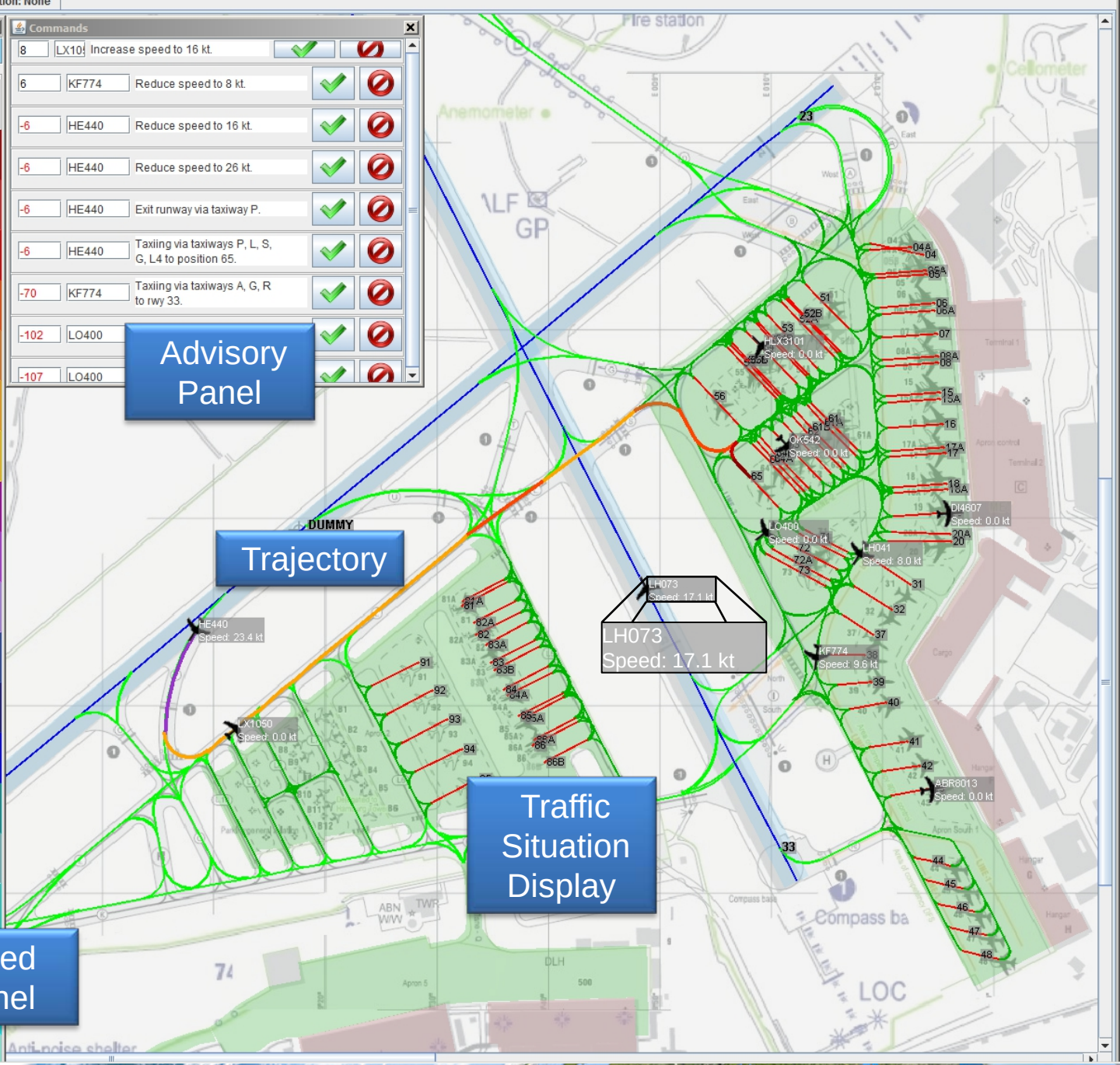
- DLR's Surface Management System (SMAN) prototype
- Conflict-free time-based trajectories on ground
- Speed and route advisories for air traffic controllers (ATCO)



Expand Time: 08:58:11

Active Flights				
AC-ID	Arr / Dep	ALDT	AOBT	Ti
HE440	arr	08:57:26		
LX1050	arr	08:54:33		
KF774	dep			08:46
LH041	dep			08:48
LO400	dep			08:50
LH073	dep			08:45

Spe
Pann



A First Feasibility Workshop: Human-in-the-loop (HITL) Simulations

Aims

Feasibility and acceptance of time-based concept

Usability of TRACC HMI

Applicability of the coupled CADEO and TRACC

Assumptions

Airport Collaborative Decision Making

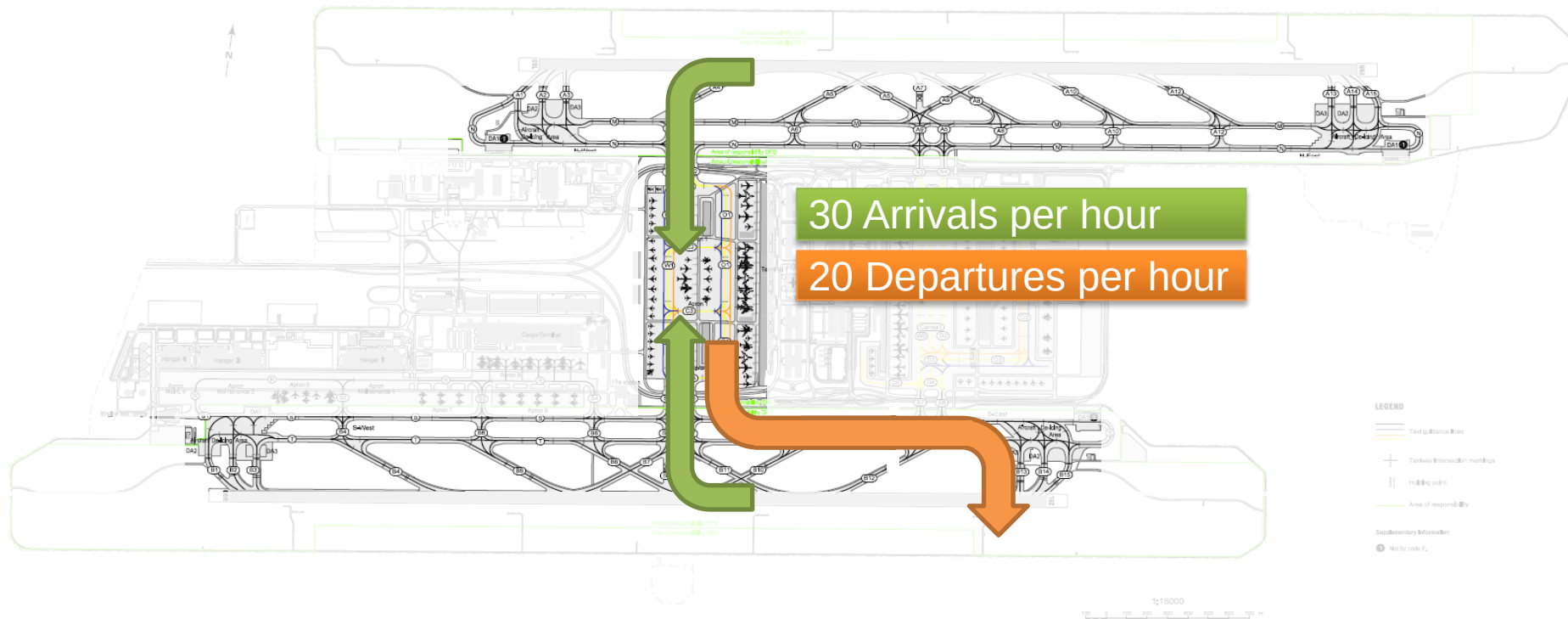
4D-Flight Management System

Compliance of arriving aircraft

Execution of exact taxi speeds



Layout and Traffic Flow



Simulation Environment



Simulation Environment

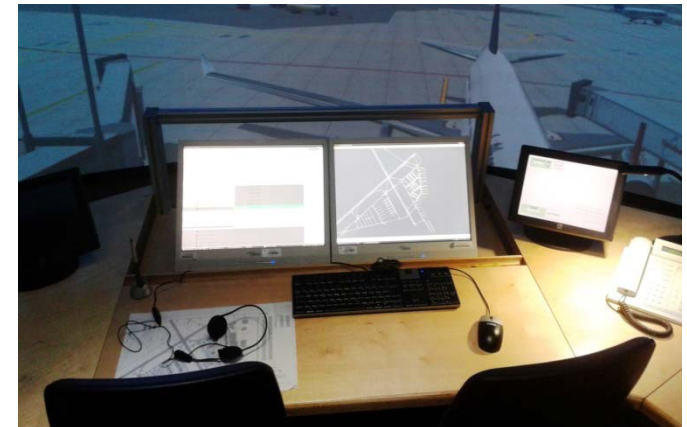


Experimental Design

Schedule	
Baseline training (ca. 30 min)	Distance-based operational procedures EFS, Ground Radar
Baseline (ca. 60 min)	
TRACC training (ca. 30 - 50 min)	Time-based operational procedures TRACC HMI
TRACC (ca. 60 min)	
TRACC & CADEO (ca. 60 min)	

Participants: 4 Air Traffic Controllers

Selection factors: location, age, certification
experience



Measures

During runs: comments



After runs: semi-structured guided interviews

- Guaranties discussion of all topics
- Allows ATCOs to select focus

Interview Topics

Concept and Implementation

Precise Speed Advisories

Stability and reliability of trajectories

Optimization parameters

Acceptability

Satisfaction

Efficiency

Usability of the TRACC HMI

Information:

Arrangement, timeliness, quantity

Conflict and critical events notifications

Traceability

Transparency

Plausibility



Results

More than 500 Answers and Comments

Favorable

Neutral/
Nonspecific

Critical

Ideas for
Improvements

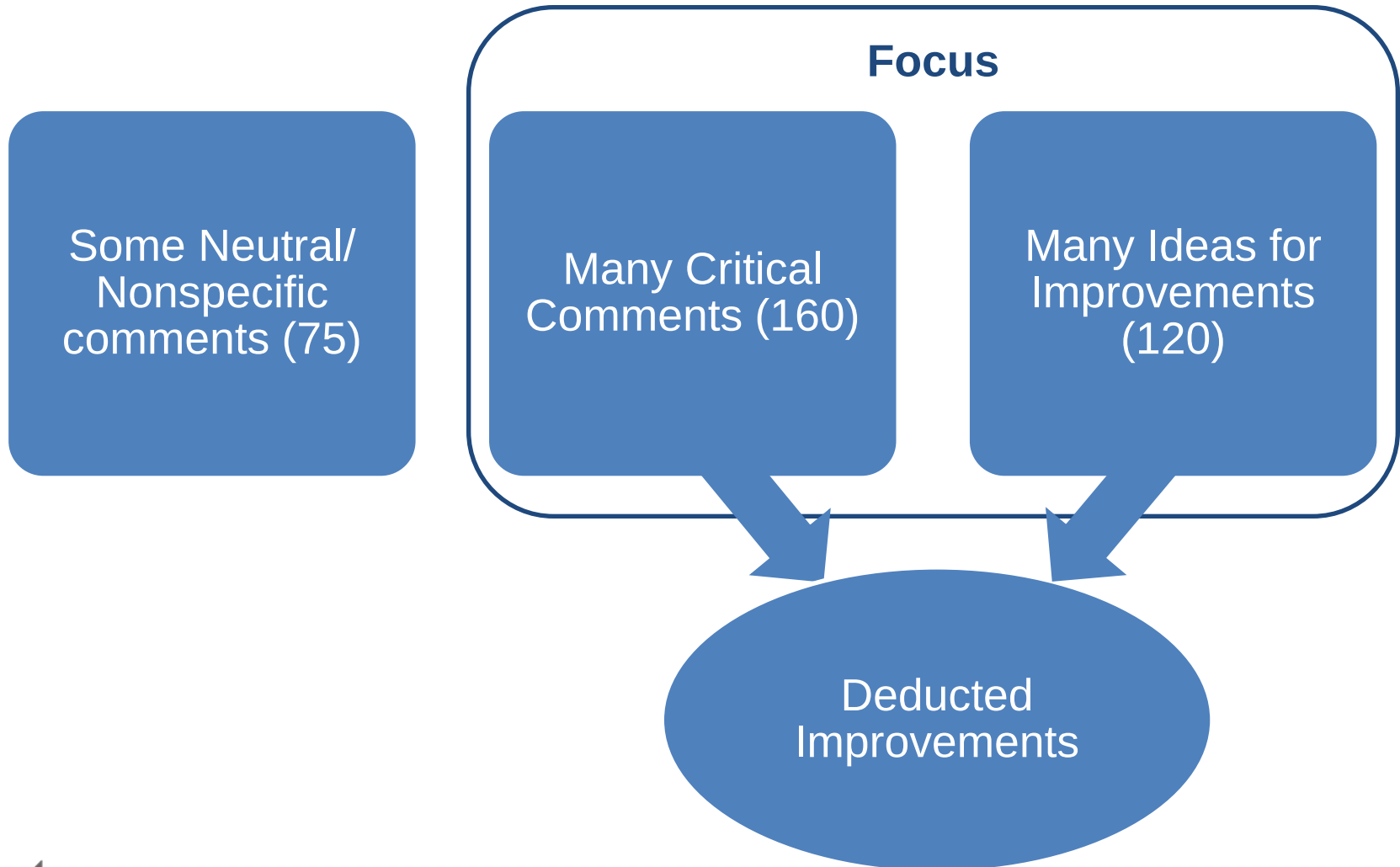


Considerable amount of
favorable comments (190)

- Concept generally accepted
- Planned trajectory in traffic situation display was valuable



Results II



Deducted Improvements

Concept and Implementation

Higher stability of trajectories/
Less frequent adaptations

Increased safety buffers

Less speed changes in trajectory

Reduced amount of curves

Automatic command transmission
(e.g. data link)

Usability of the TRACC HMI

Information in flight tables optional

Clearance status and remarks

More information in aircraft label
(e.g. last speed command)

Connect corresponding information
by highlighting

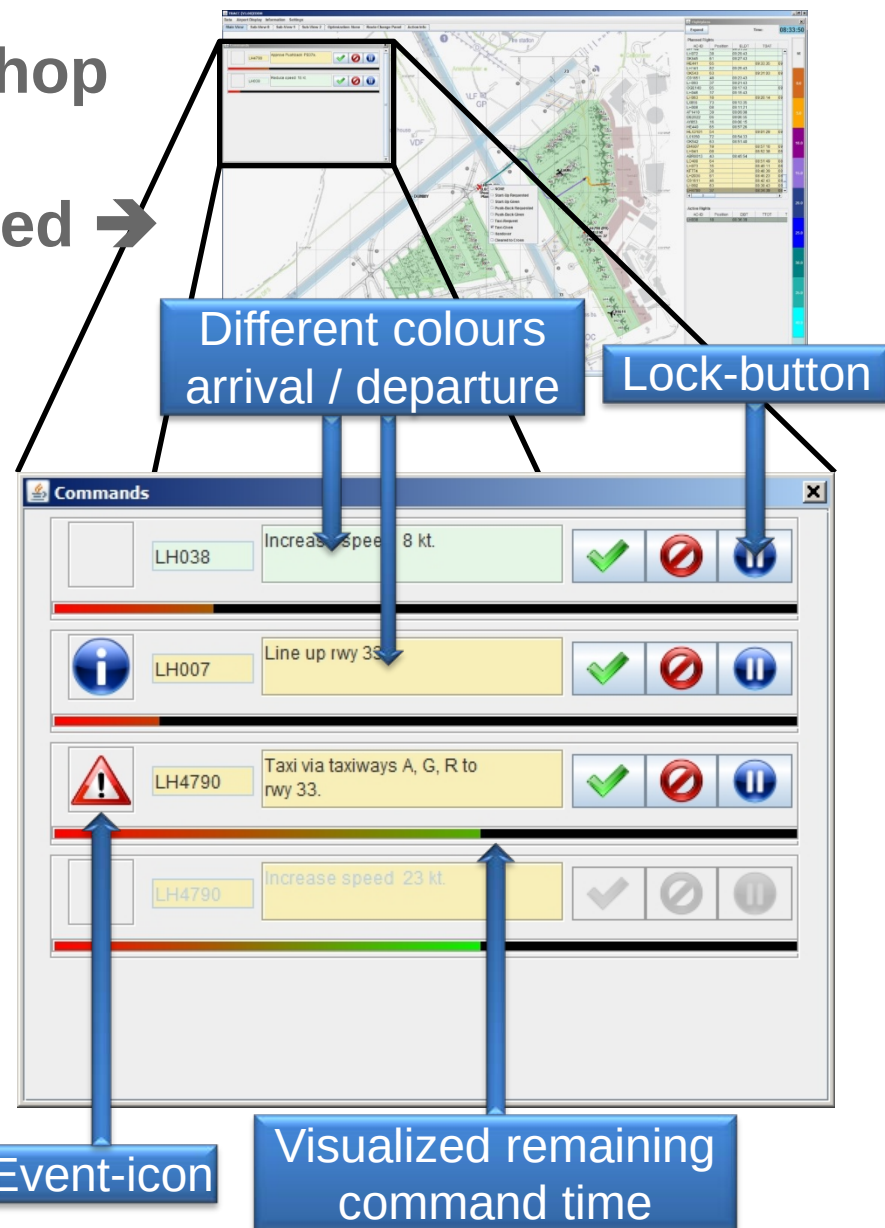
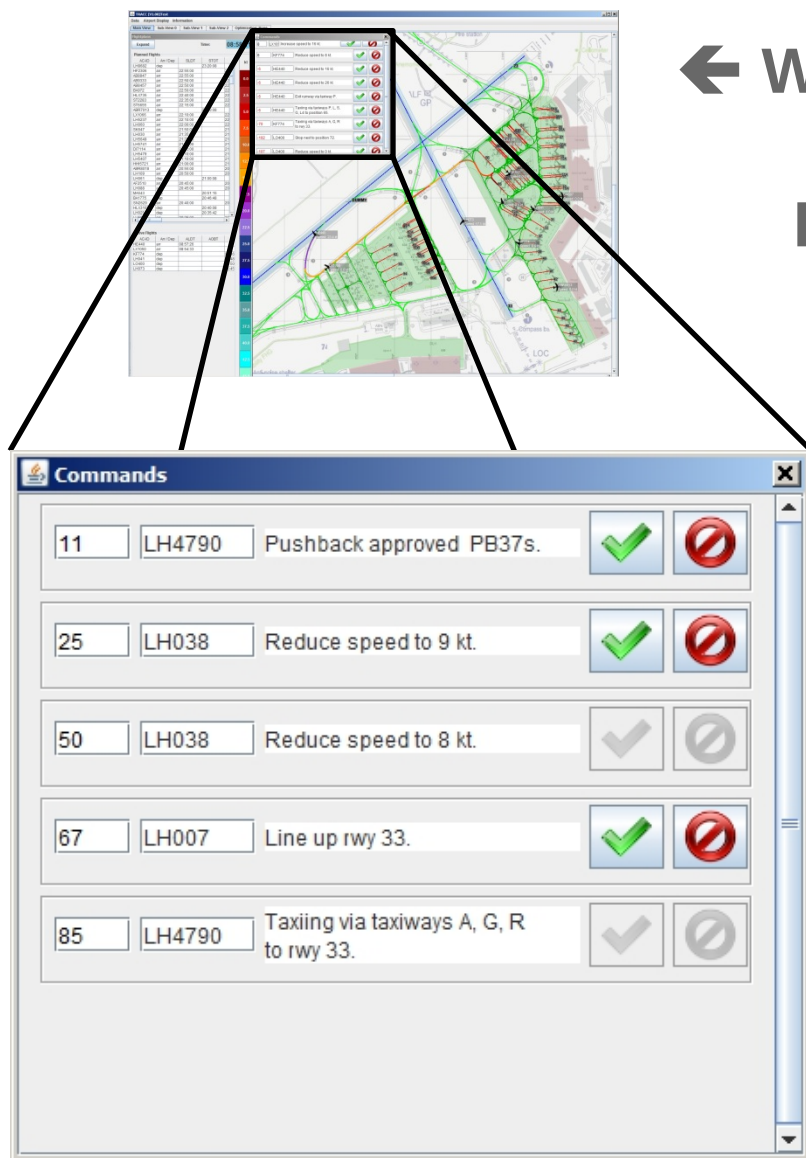
Button to prevent disappearing of
advisories

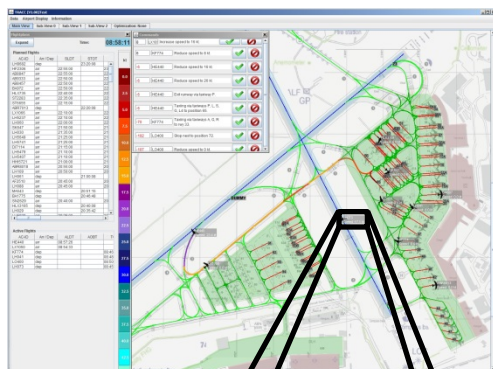
Transparency of reasons for adaptations



← Workshop

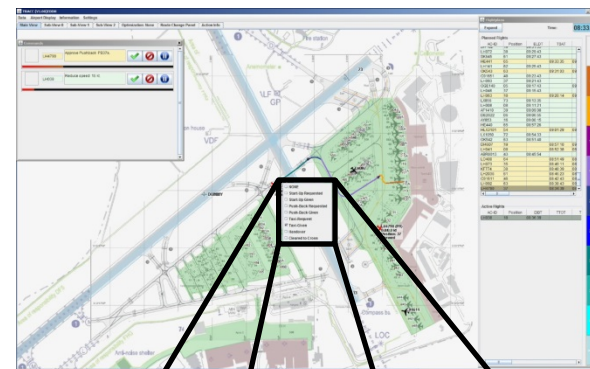
Revised →





No status
input / output display
available

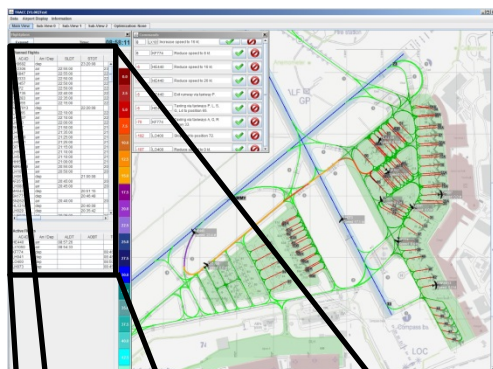
← Workshop
Revised →



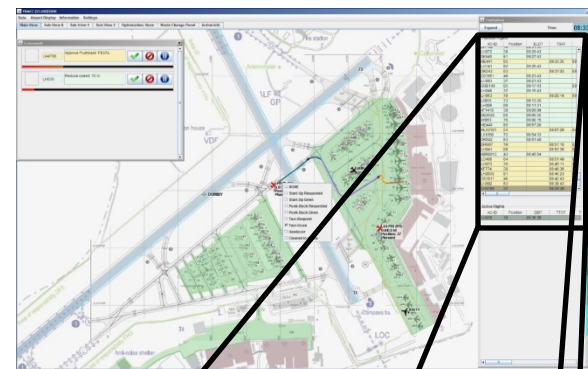
- ☐ NONE
- ☐ Start-Up Requested
- ☐ Start-Up Given
- ☐ Push-Back Requested
- ☐ Push-Back Given
- ☐ Taxi-Request
- ☒ Taxi-Given
- ☐ Handover
- ☐ Cleared to Cross

Status selection
panel





← Workshop
Revised →



Planned Flights				
AC-ID	Arr / Dep	SLDT	STOT	
LH8682	dep		23:20:08	
HF2306	arr	22:55:00		23
AB8847	arr	22:55:00		22
AB9333	arr	22:50:00		22
AB8457	arr	22:50:00		22
BA972	arr	22:50:00		22
HLX735	arr	22:40:00		22
ST2283	arr	22:35:00		22
ST6655	arr	22:15:00		22
ABR7013	dep		22:20:08	
LX1066	arr	22:10:00		22
LH5237	arr	22:10:00		22
LH060	arr	22:00:00		22
SK647	arr	21:50:00		21
LH030	arr	21:35:00		21
LH5649	arr	21:25:00		21
LH5741	arr	21:25:00		21
DI7114	arr	21:15:00		21
LH5479	arr	21:10:00		21
LH5407	arr	21:10:00		21
HHI5721	arr	21:00:00		21
ABR8018	arr	20:55:00		20
LH109	arr	20:50:00		20
LH061	dep		21:00:08	
AF2510	arr	20:45:00		20
LH088	arr	20:45:00		20
MA543	dep		20:51:15	
BA1775	dep		20:46:48	
SN2629	arr	20:40:00		20
HLX3105	dep		20:40:08	
LH029	dep		20:35:42	
LH5650	arr	20:05:00		20

Different colours
arrival / departure

Planned Flights				
AC-ID	Position	ELDT	TSAT	
LH8682	08		23:14:47	23
HF2306	06	23:00:38		
AB8847	52A	22:58:24		
AB9333	04	22:56:11		
AB8457	07	22:53:58		
BA972	32	22:51:44		
HLX735	63	22:40:38		
ST2283	51	22:36:11		
ST6655	64	22:16:11		
LX1066	62	22:13:58		
LH5237	48	22:11:44		
ABR7013	43		22:16:52	22
LH060	18	22:00:38		
SK647	65	21:51:44		
LH030	08	21:36:11		
LH5649	45	21:27:18		
LH5741	46	21:25:04		
DI7114	37	21:16:11		
LH5479	20	21:13:58		

Active Flights				
AC-ID	Position	EIBT	TTOT	T
LH4790	37		08:38:49	
LH038	18	08:37:31		
LH007	16		08:36:35	

Conclusions & Future Work

Conclusions

- Concept is feasible
- Acceptance by ATCOs

Constraints

- Aircraft must be able to adhere to precise taxi speeds
- SMAN must be highly reliable

System Improvements

- Reduce amount of voice communication
- Increase safety margin
- Improve coupling of TRACC and CADEO

Future Work

- Validation of improved TRACC and CADEO coupling and revised HMI
- Proof benefits of coupled 4D air-ground trajectories



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QUESTIONS?



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More Information About...

- TRACC

I. Gerdes and A. Temme, “Taxi routing for aircraft: Creation and controlling – ground movements with time constraints,” in Dirk Schaefer (Editor) Proceedings of the 2nd SESAR Innovation Days (2012) EUROCONTROL, Braunschweig, Germany, 2012.

- TRACC and CADEO Coupling

M. Schaper and I. Gerdes, “Trajectory based ground movements and their coordination with departure management,” 32nd Digital Avionics Systems Conference, Syracuse, NY, USA, 2013.

- 360° Tower Simulator

S. Schier, T. Rambau, F. Timmermann, I. Metz and T. Stelkens-Kobsch, “Designing the future tower control research environment“, Deutscher Luft- und Raumfahrtkongress, Stuttgart, Germany, 2013.

