



Augmented Reality and Synthetic Vision in the Airport Control Tower: the RETINA Project

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DEMONSTRATION DAY

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Founding Members



EUROPEAN UNION



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RETINA concept

RETINA (Resilient Synthetic Vision for Advanced Control Tower Air Navigation Service Provision) is the concept of enhancing human sight capabilities and situation awareness in the control tower by means of synthetic vision.

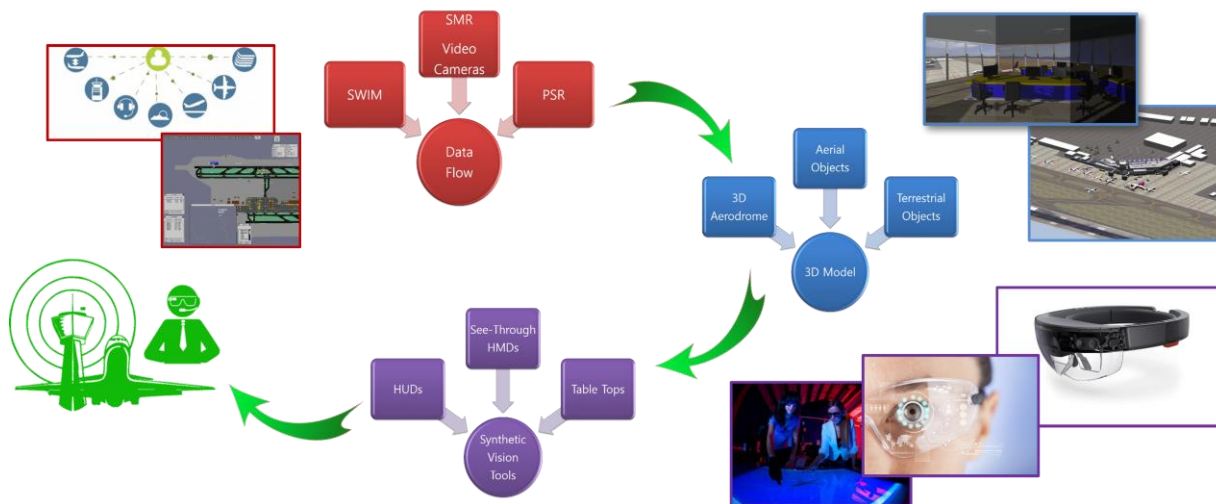


RETINA concept

In the RETINA concept, controllers are no longer limited by what the human eye can physically see out of the tower windows.

As trust in digital data will continue to grow, RETINA's concept allows the controller to have a head-up view of the airport traffic even in low visibility conditions similar to the synthetic vision currently used in the cockpit.

RETINA builds upon the technologies developed in SESAR, such as remote tower, safety nets, SWIM, to provide augmented reality tools for the tower controller.



EXPECTED IMPACTS



SAFETY



ENVIRONMENT



EFFICIENCY



COSTS

RETINA concept: motivation

Image: Washington International Airport (1962)

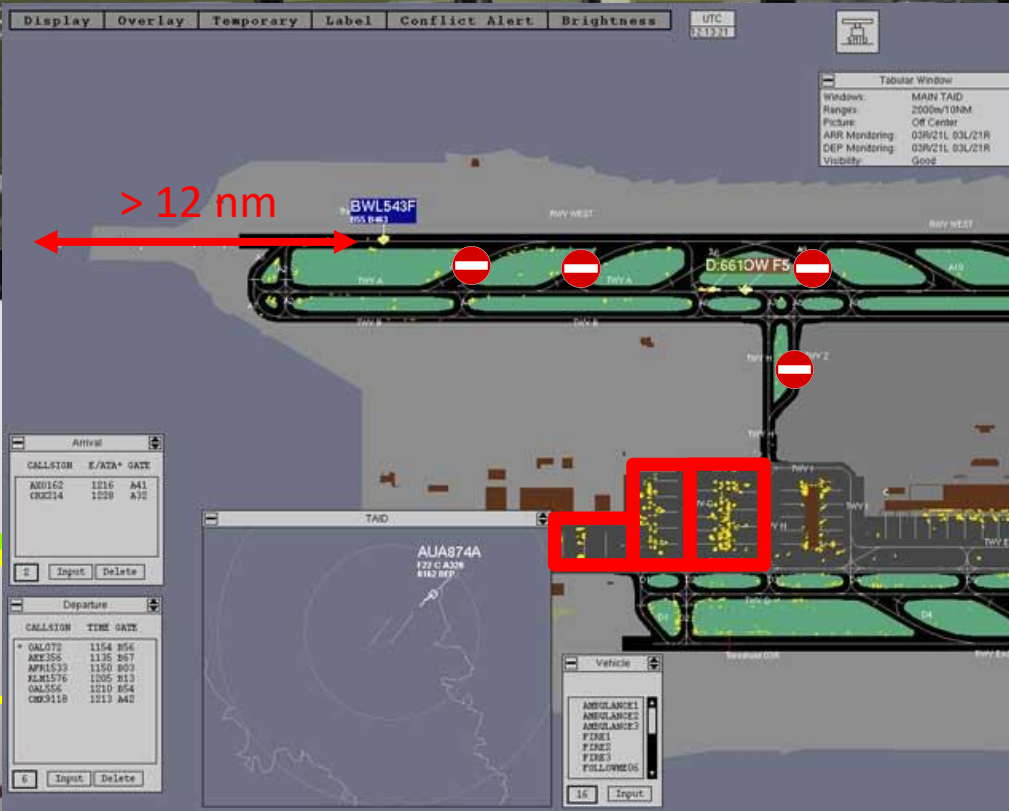


Image: Liverpool International Airport (nowadays)



*Normal Visibility Conditions

Low Visibility Procedures



RETINA concept



RETINA HMD

SEE-THROUGH HEAD-MOUNTED DISPLAY



DEPARTURES				ARRIVALS			
ID	Type/WCAT	ICAO Class	CTOT/EOBT	ID	Type/WCAT	ICAO Class	CTOT/EOBT
Ready/	Speed			DTD	Altitude	Speed	Clearance to land



OUTSIDE VIEW

AR OVERLAY

COMBINED VIEW



RETINA HMD

SEE-THROUGH HEAD-MOUNTED DISPLAY



RETINA SD

SEE-THROUGH SPATIAL DISPLAY



DEPARTURES				ARRIVALS			
↓				↓			
ID	Type/WCAT	ICAO Class	CTOT/EOBT	ID	Type/WCAT	ICAO Class	CTOT/EOBT
Ready/	Speed			Clearance to land			



OUTSIDE VIEW



AR OVERLAY

AZA123	A332 H	C	RYP321	B738 M	C
1 NM	318 FT	140 KT	CTOT 12:30		
CLEARED TO LAND			READY		

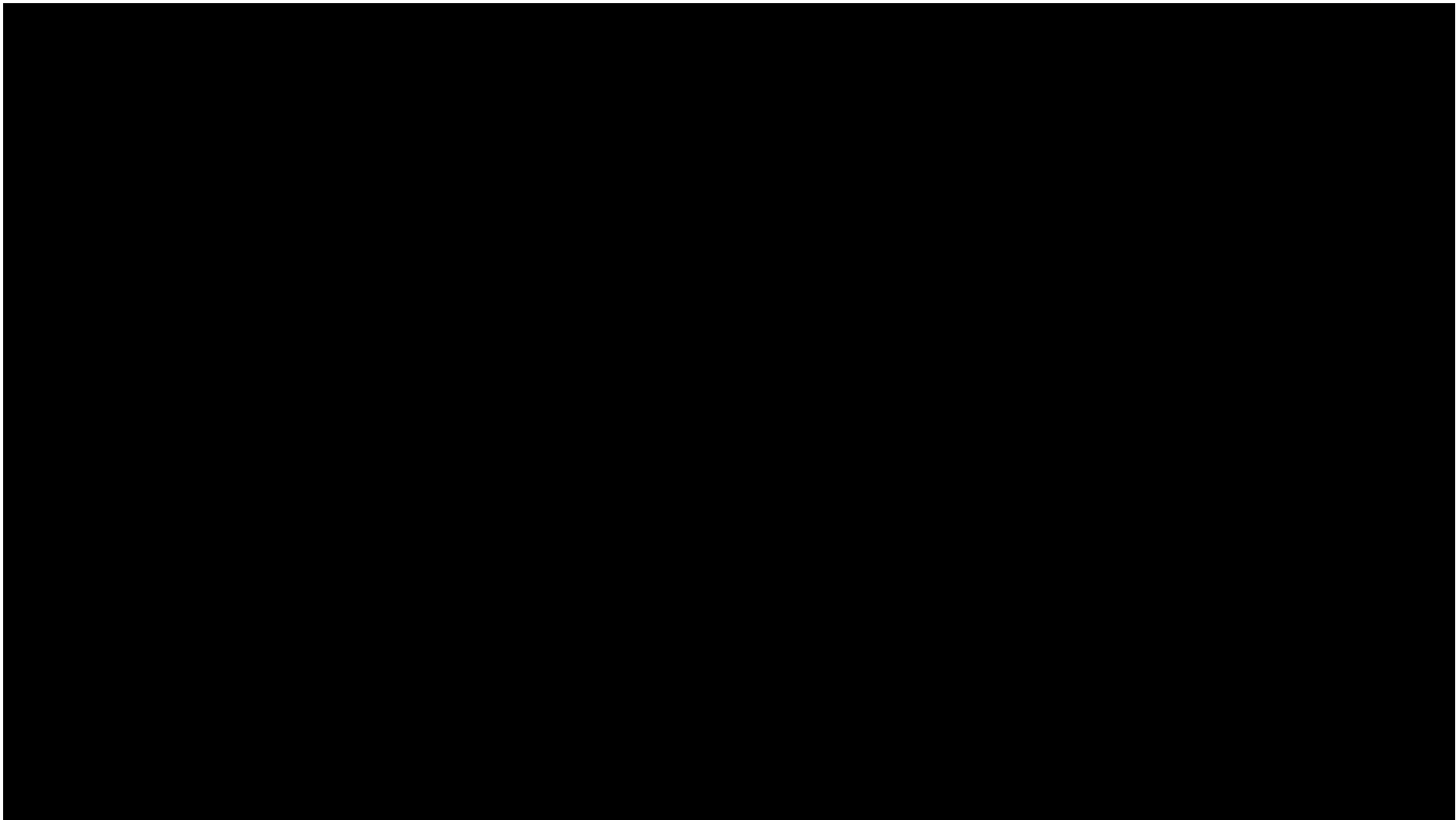
COMBINED VIEW



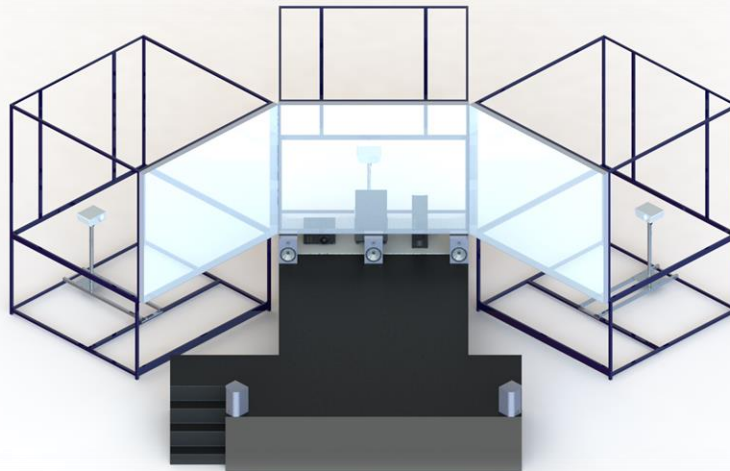
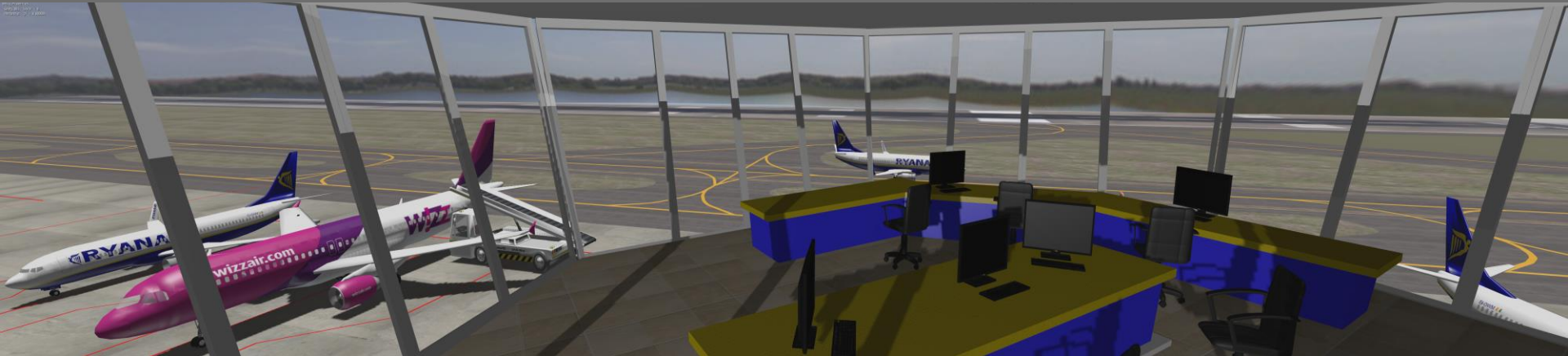
RETINA SD

SEE-THROUGH SPATIAL DISPLAY

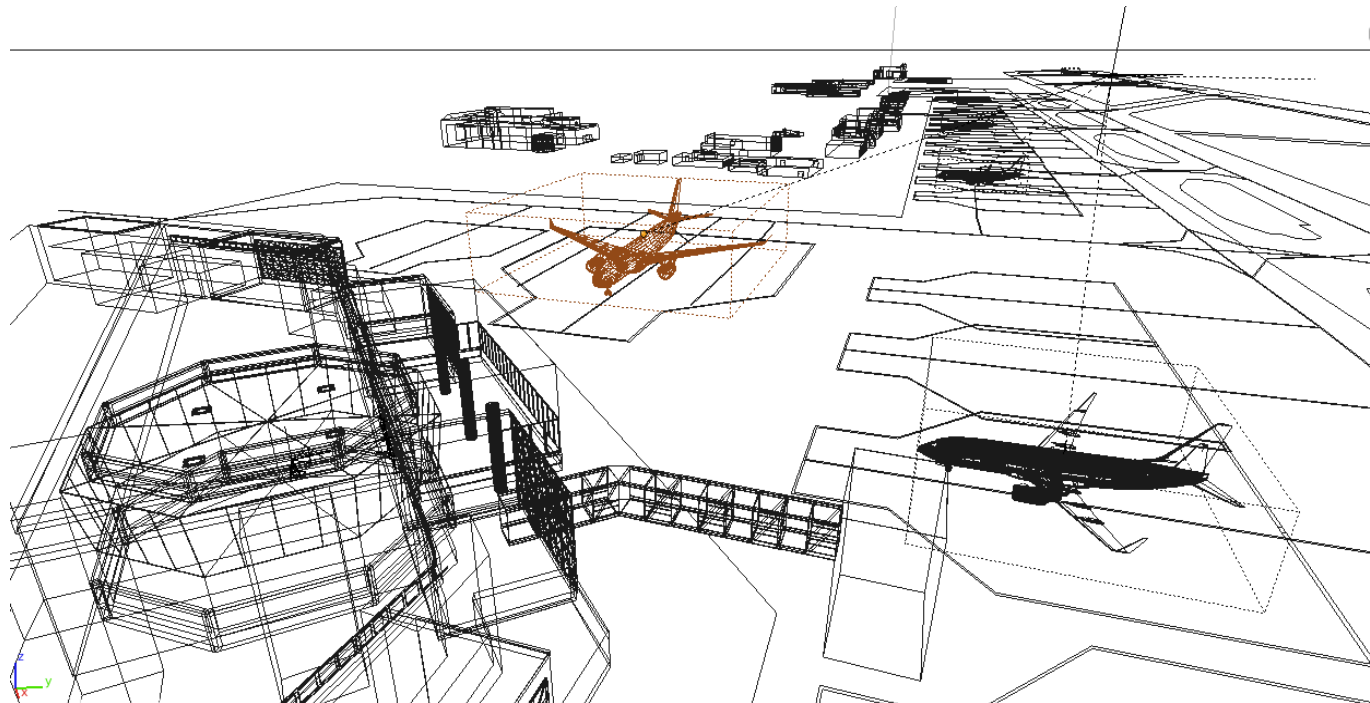
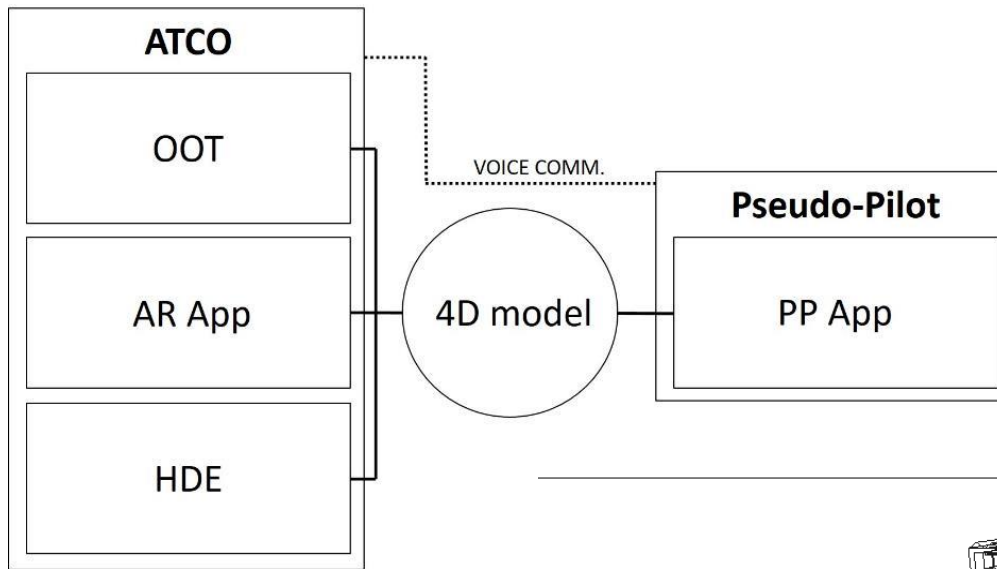




Validation Platform



Validation Platform



Visibility Conditions



Baseline – Spatial Display – Head Mounted Display

**BASLINE
EQUIPMENT**



**RETINA SPATIAL
DISPLAY EQUIPMENT**



**RETINA HEAD MOUNTED
DISPLAY EQUIPMENT**

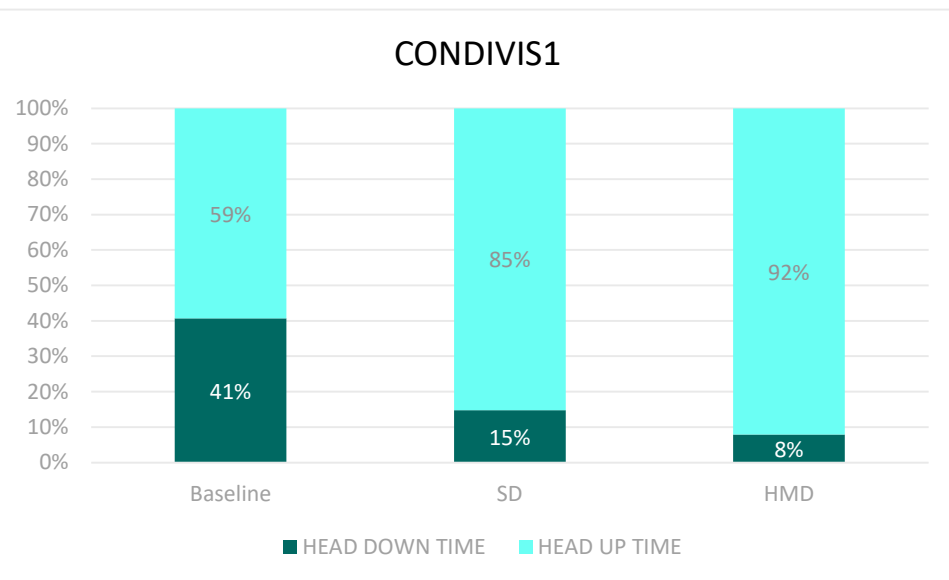


Experimental Plan

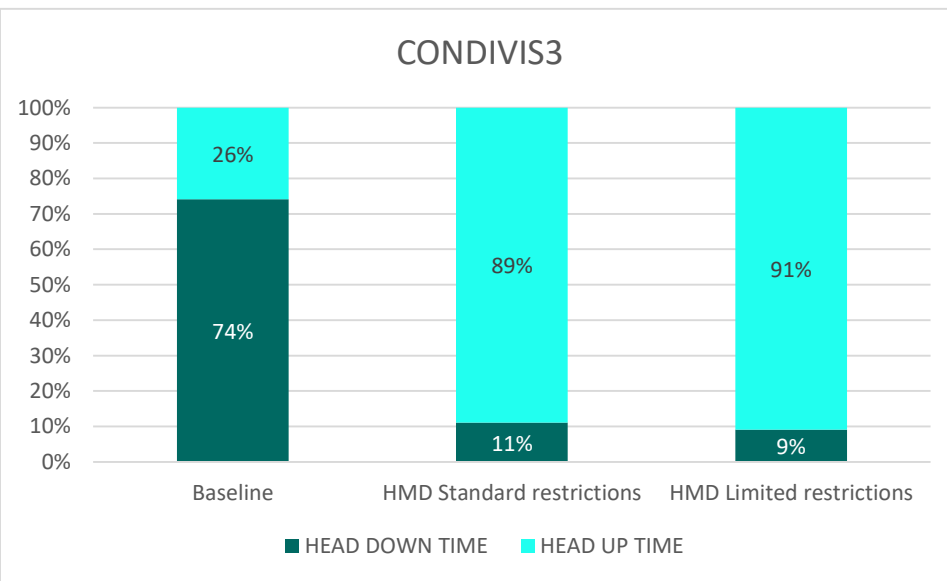
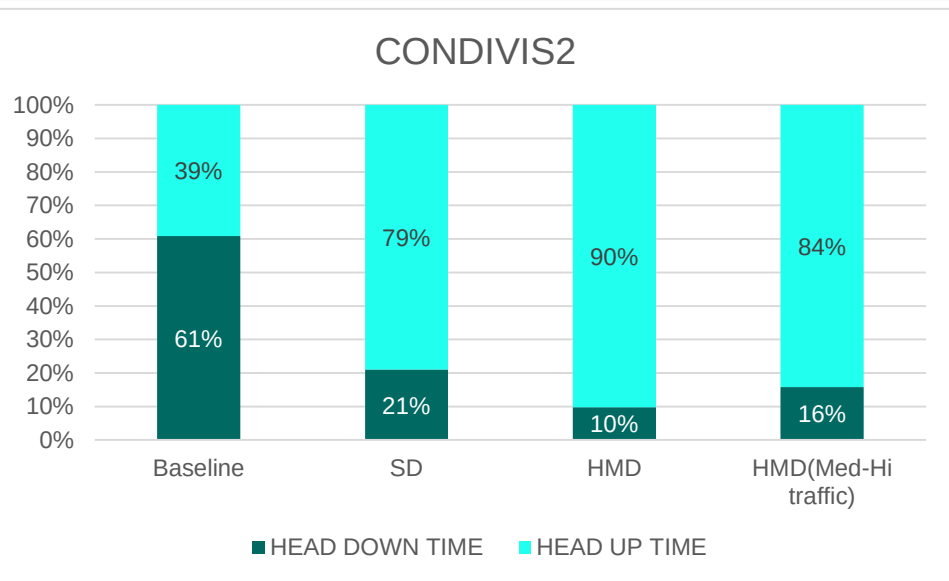
Batch	CONDIVIS	EQUIPMENT			
		BASELINE	HMD		SD
Batch1	CONDIVIS 1	EXE1 MEDIUM-HIGH TRAFFIC	EXE2 MEDIUM-HIGH TRAFFIC		EXE3 MEDIUM- HIGH TRAFFIC
Batch2	CONDIVIS 2	EXE4 MEDIUM TRAFFIC	EXE5 MEDIUM TRAFFIC	EXE7 MEDIUM-HIGH TRAFFIC	EXE6 MEDIUM TRAFFIC
Batch3	CONDIVIS 3	EXE8 MEDIUM TRAFFIC STANDARD RESTRICTIONS	EXE9 MEDIUM TRAFFIC STANDARD RESTRICTIONS	EXE 10 MEDIUM TRAFFIC LIMITED RESTRICTIONS	
Batch 4	EXE11 USABILITY TEST				

Validation Exercise 1-10	
Subjective Measurements	• Questionnaires: to assess workload, performance and information accessibility. • Debriefs: to record the opinions and feelings of participants with respect to the operational concept.
Objective Measurements	• Head down time • Head up time • Number of switches head-down/head-up • Throughput

Results: Head-Down vs Head-Up Time

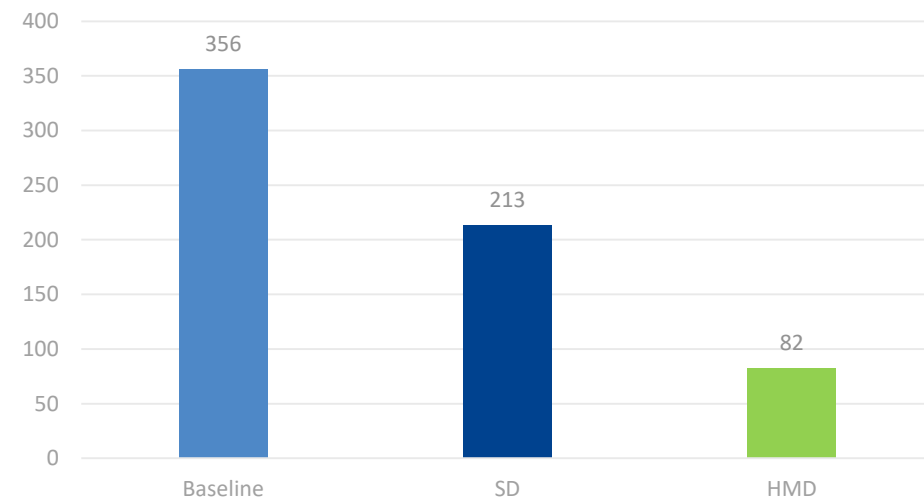


- **RETINA Solutions Provide a Dramatic Reduction of Head-Down Time**
- **The effect is maximized by HMD solution**



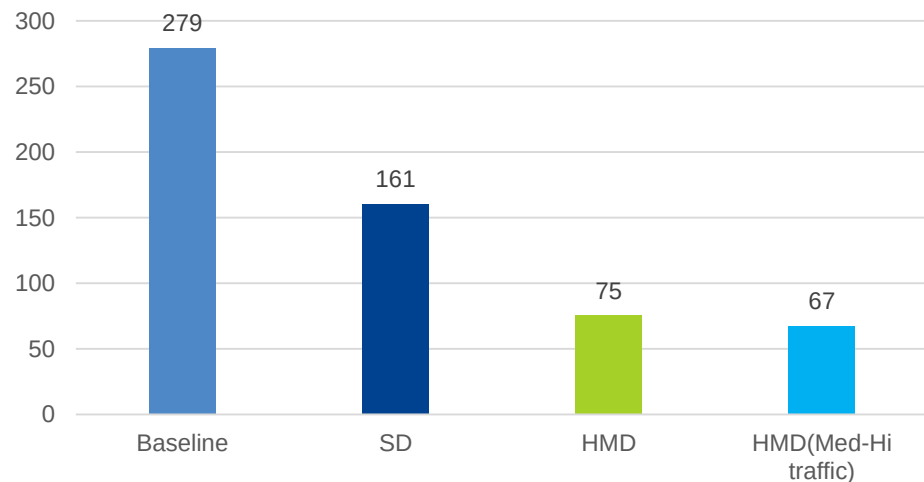
Results: Number of Switches

CONDIVIS1 No. of Switches

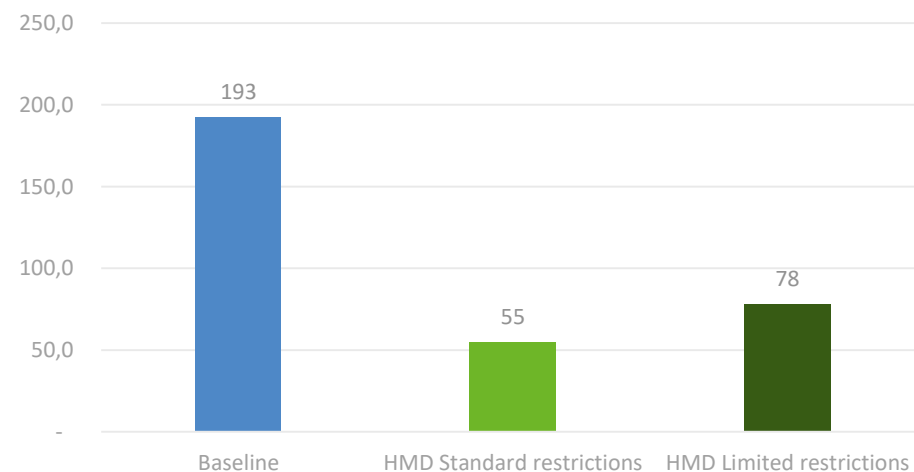


- **RETINA Solutions Provide a Dramatic Reduction of the No. of Switches Head Down-Head Up**
- **The effect is maximized by HMD solution**

CONDIVIS2 No. of Switches

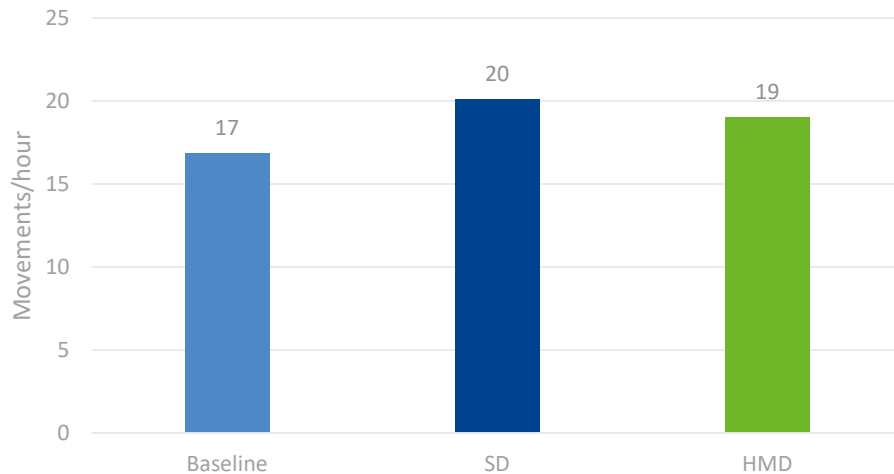


CONDIVIS3 No. of Switches



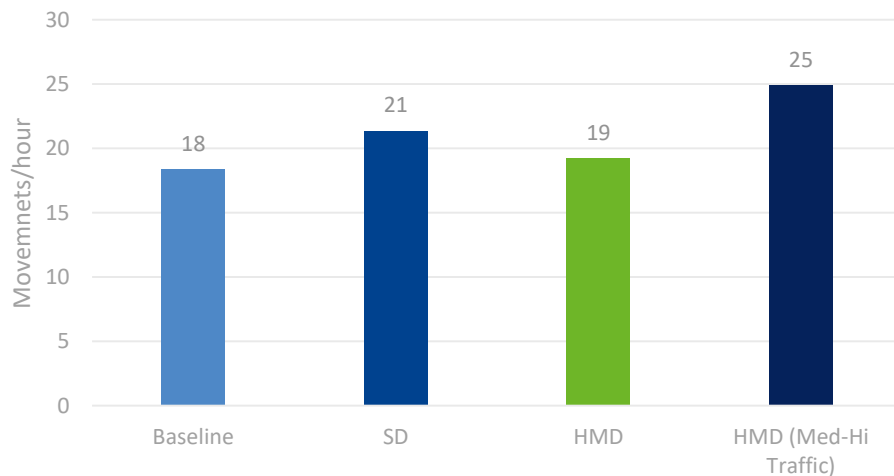
Results: Throughput

CONDIVIS1 Throughput

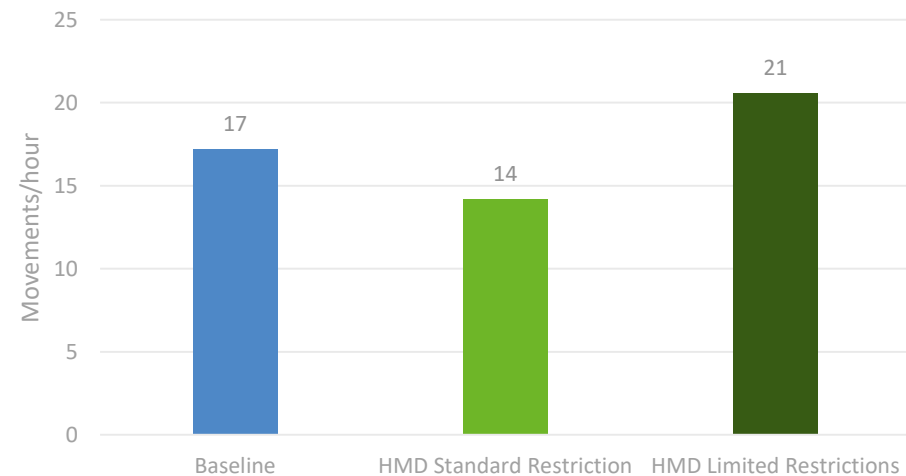


- **RETINA Solutions Provide an overall increase in the throughput**

CONDIVIS2 Throughput

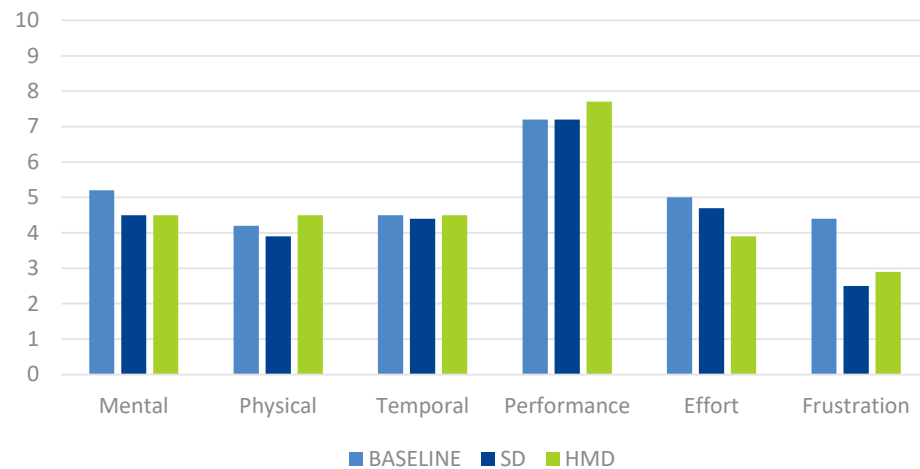


CONDIVIS3 Throughput



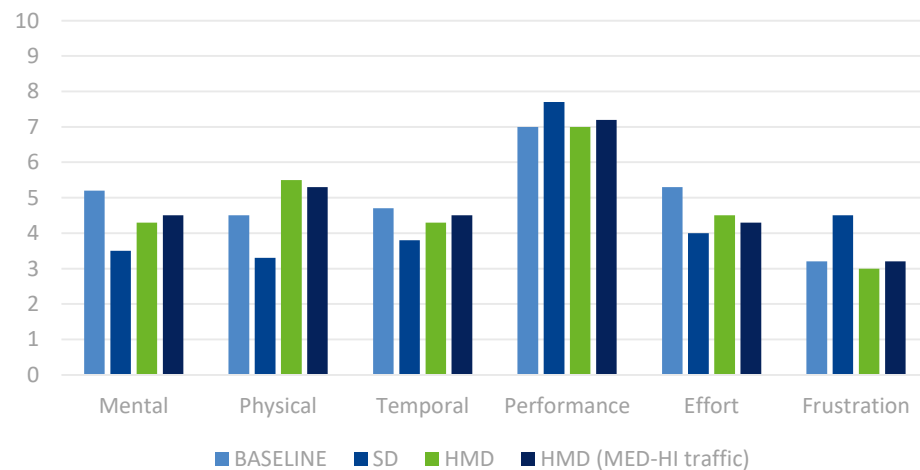
Results: Workload and Performance

CONDIVIS1 - Perceived Workload (NASA TLX)

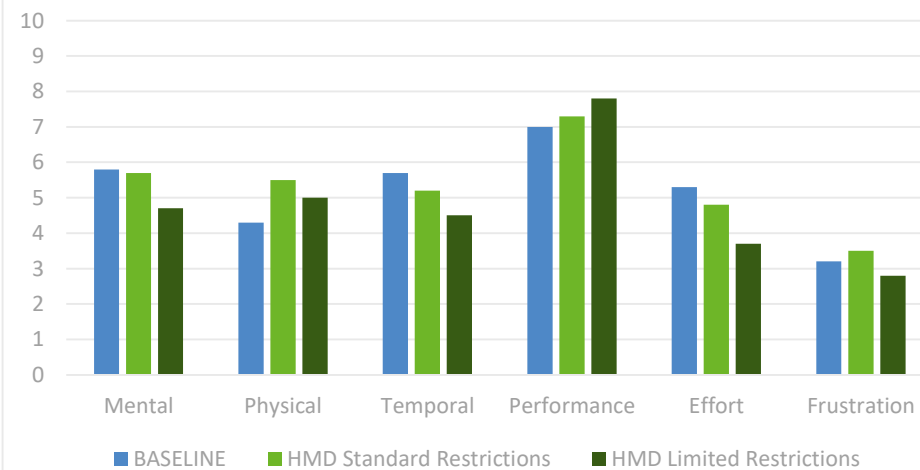


- **RETINA Solution SD provides a significant reduction of all workload components**
- **RETINA Solution HMD provides an overall increase in performance, but it also increases physical workload**

CONDIVIS2 - Perceived Workload (NASA TLX)

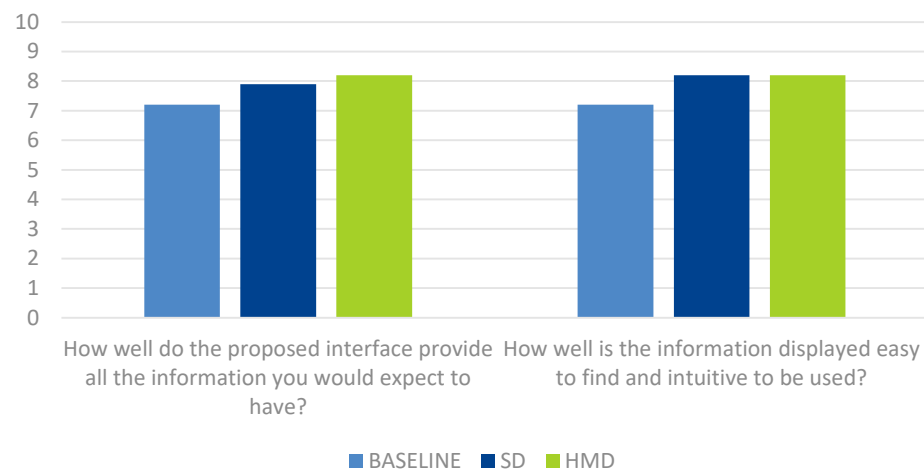


CONDIVIS3 - Perceived Workload (NASA TLX)



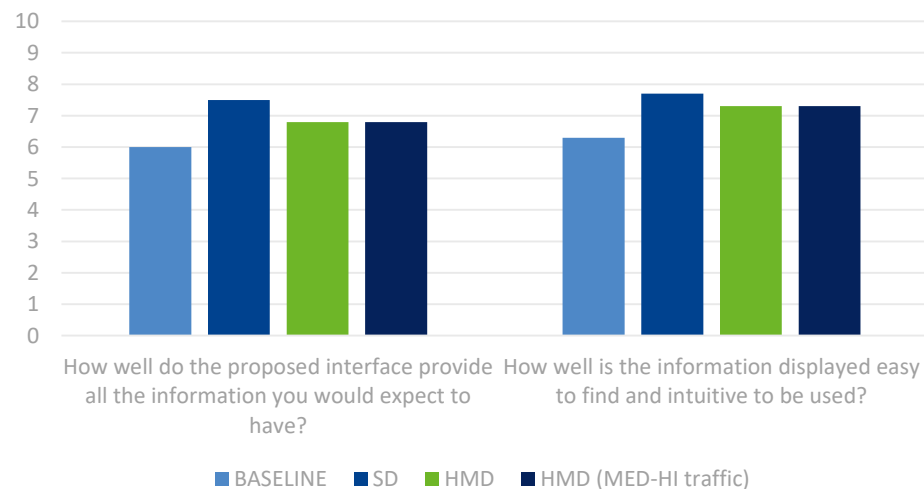
Results: Information Accessibility

CONDIVIS1 - Information Accessibility

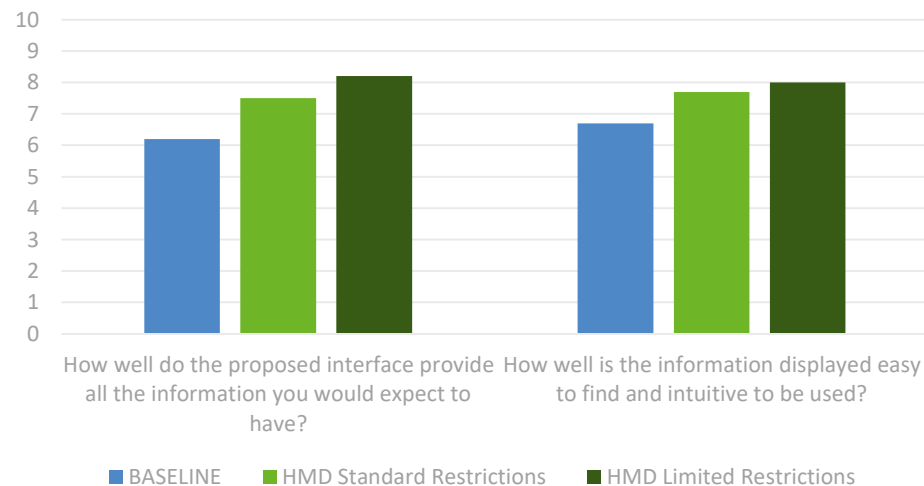


- **RETINA Solutions provide an increase in information accessibility**

CONDIVIS2 - Information Accessibility



CONDIVIS3 - Information Accessibility



- The RETINA concept has a clear effect in stimulating the ATCO to work in a head-up position more than in a head-down position.
- The ATCO is provided with a unique conformal representation of all the needed information that is currently provided by means of several visual inputs.
- When low visibility conditions apply, the use of RETINA tools provides the ATCO with a head up conformal view of all needed information, leading to the reduction of current restrictions due to LVP.
- The operational benefits provided by the two conceptual solutions explored, namely HMD and SD, are comparable.