

# EUROCAE Industrial Standardisation

Minimum aviation system performance  
specifications for remote tower optical systems (WG100/ED240A)

Jörn Jakobi (DLR)

EUROCAE WG100 Chairman &  
SESAR PJ05 Project Coordinator



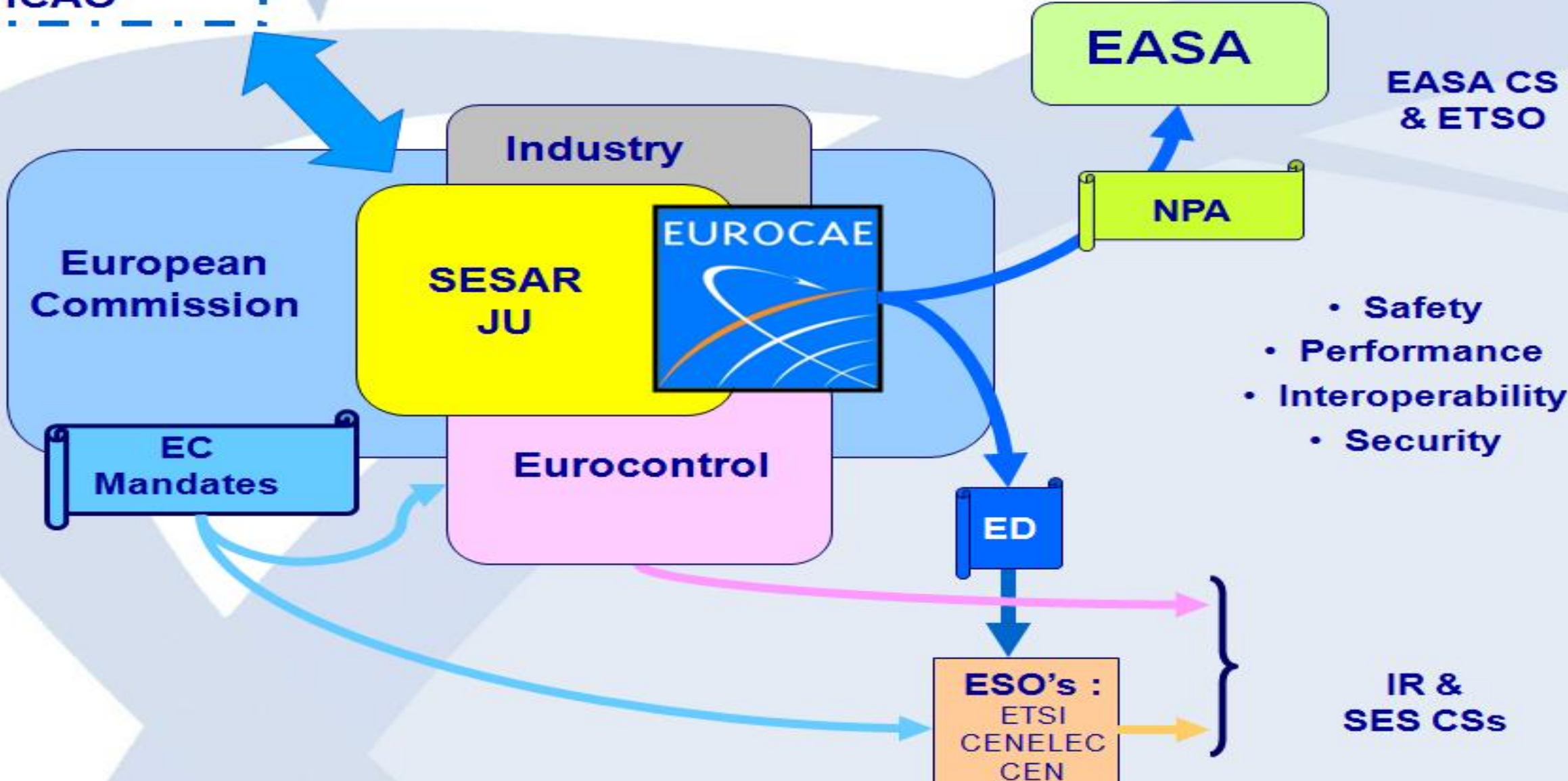
Wissen für Morgen





# EUROCAE's Role Place in the CS Development Process

ICAO



# EASA Rule Making Group (RMT.0624)

- “Technical requirements for remote tower operations”
- Adoption of industry standards (EUROCAE ED-240).
- Existing publication:
  - Guidance Material on “Single”,  
via [ED Decision 2015/014/R](#)
  - & High-Level Guidance/Requirements on ATCO licensing,  
via [ED Decision 2015/015/R](#)
- Amendments w.r.t. “multiple and more complex mode of operations” by end of 2018



# ICAO Consideration 1/4

*Establishment of an aerodrome control service does not necessarily imply the immediate provision of a special ATC facility (control tower)*

*...adequately qualified ATC personnel, having means and facilities at their disposal appropriate for the given situation.*

(ICAO doc 9426\*)

\*ICAO Doc 9426 (Dez. 1992) - Air Traffic Services Planning Manual  
PART 1 – SECTION 2 – Establishment of Air Traffic Services  
Chapter 1 – Need for Air Traffic Services / Paragraph 1.5.3



# ICAO Consideration 2/4

*The tower must permit the controller to survey those portions of the aerodrome and its vicinity over which he exercises control;*

*The tower must be equipped so as to permit the controller rapid and reliable communications with aircraft with which he is concerned.  
(ICAO doc 9426\*)*

## **ESSENTIAL OPERATIONAL REQUIREMENT**

\*ICAO Doc 9426 - Air Traffic Services Planning Manual  
PART III – Section 2 – Facilities required by Air Traffic Services  
Chapter 2 - Specific Requirements for an Aerodrome Control Tower / Paragraph 2.1.1



# ICAO Consideration 3/4

*The controller must be able to **discriminate** between aircraft and between aircraft and vehicles while they are on the same or different runways and/or taxiways.*

(ICAO doc 9426\*)

## **ESSENTIAL OPERATIONAL REQUIREMENT**

\*ICAO Doc 9426 - Air Traffic Services Planning Manual  
PART III – Section 2 – Facilities required by Air Traffic Services  
Chapter 2 - Specific Requirements for an Aerodrome Control Tower / Paragraph 2.1.2



# ICAO Consideration 4/4

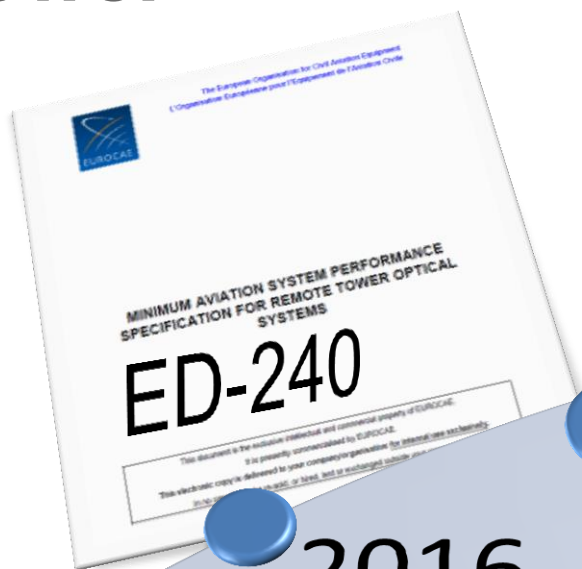


## ICAO ATMOPSP/WG/3 Proposal for PANS-ATM, Doc 4444 7.1.1.2.1

*Visual observation shall be achieved through direct out of the window observation or through indirect observation **utilizing a visual surveillance system...***



# EUROCAE WG100 „Remote and Virtual Tower“



2015

EASA RMG.0624  
ED Decision 2015/014/R

2016

2017

EASA NPA 2017-21  
ED Decision 2015/014/R  
with updated GM & AMC to  
EU 2015/340

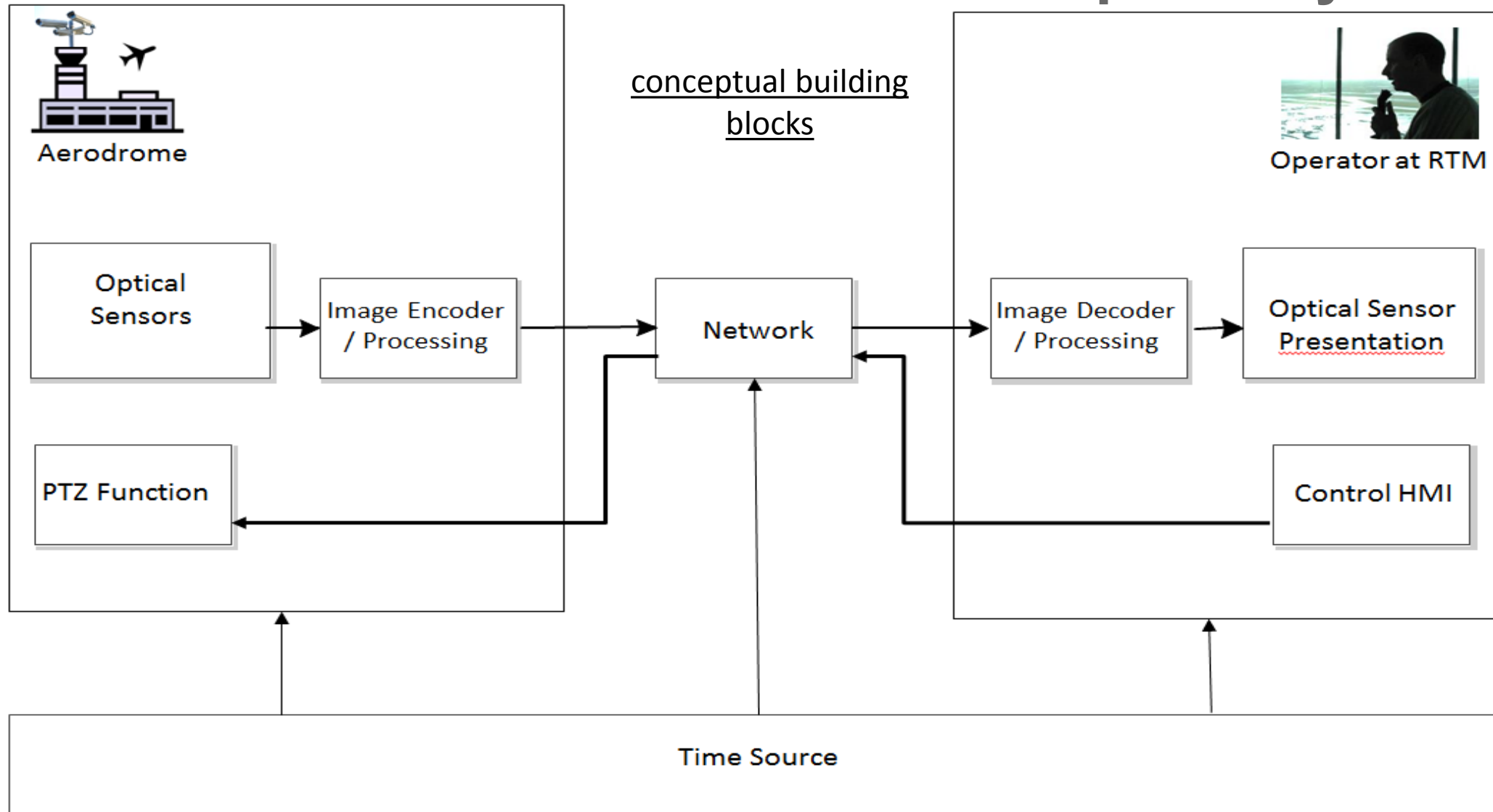
2018

ICAO Doc4444  
amendment proposal

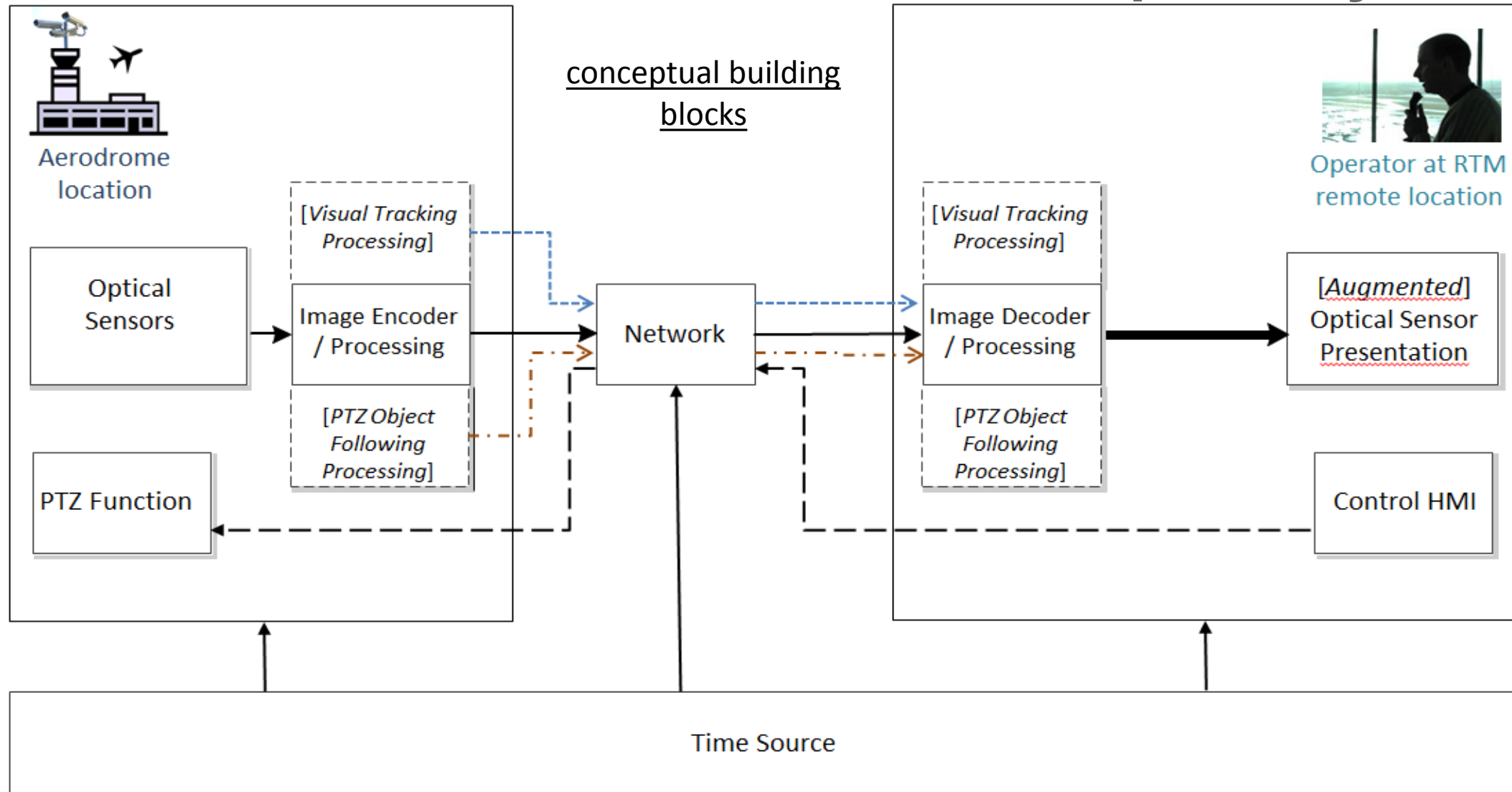
Launch of  
EUROCAE WG-100 2014



# EUROCAE ED-240: “Remote Tower Optical System”



# EUROCAE ED-240A: “Remote Tower Optical System”

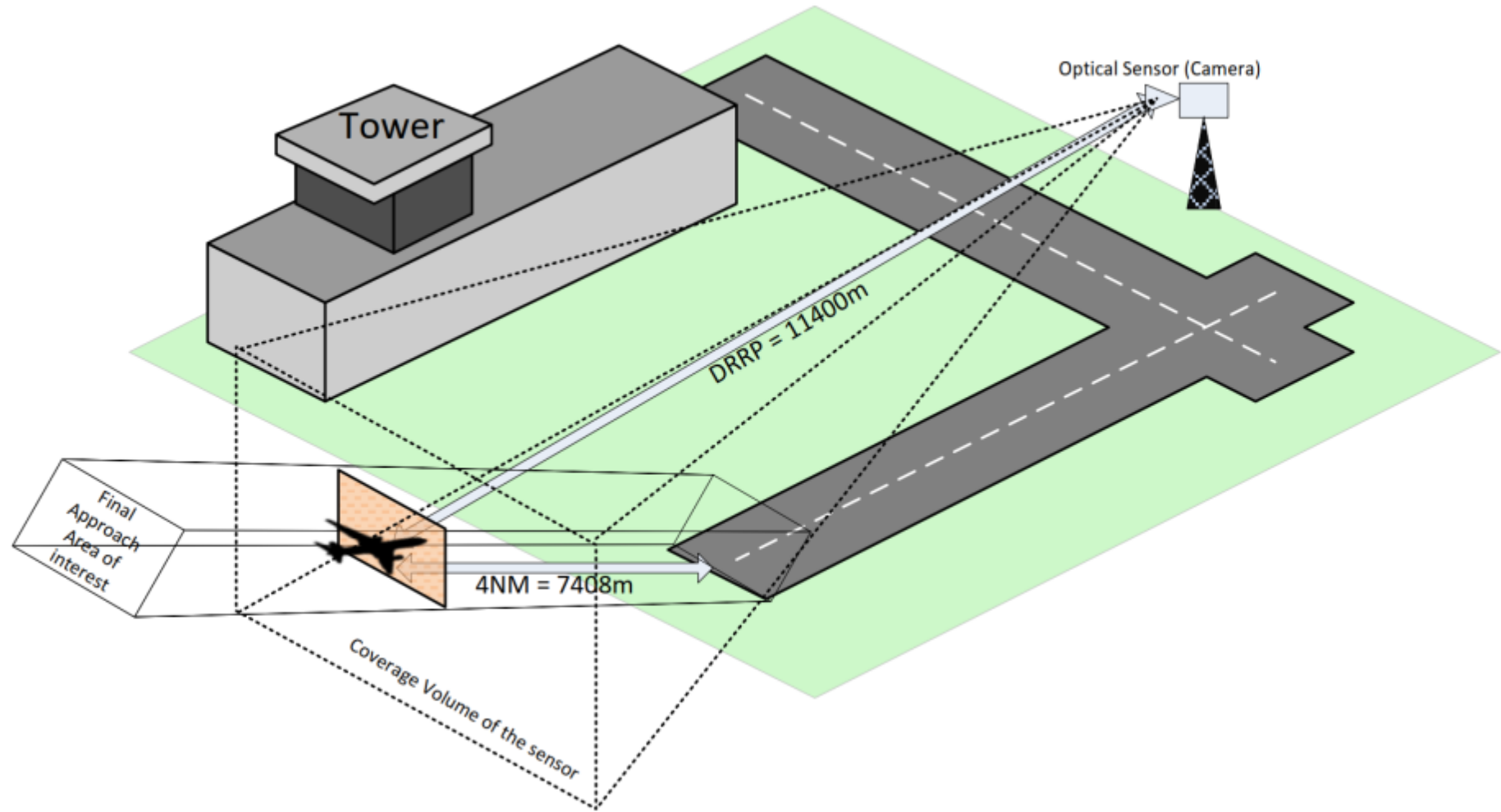


# ED-240A Requirements

Section [REQ]	Name	Value
3.2.1 [REQ 01]	Detection and Recognition Range (DRRP)	Operator Acceptance
3.2.1 [REQ 01]		$\leq 1$ s
3.2.2 [REQ 02]	Latency	$> 1$ fps
3.2.3 [REQ 03]	Video Update Rate	Operator Acceptance
3.2.3 [REQ 03]	Video Update Rate	$\leq 2$ s
3.2.3 [REQ 04]	Video Update Rate	$\leq 2$ s
3.2.4 [REQ 05]	Video Failure Notification Time	$\leq 250$ ms
3.2.5 [REQ 06]	PTZ Function Control Latency	$\geq 60^\circ/\text{s}$
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3.2.6 [REQ 07]	PTZ Tilt Speed	$\leq 2$ s
3.2.6 [REQ 08]	PTZ Pan Positioning	$\leq 2$ s
3.2.6 [REQ 09]	PTZ Tilt Positioning	$\leq 100$ ms
3.2.6 [REQ 10]	PTZ Tilt Positioning	$\leq 100$ ms
3.2.7 [REQ 11]	Time Synchronisation	N/A
3.2.8 [REQ 12]	Video Jitter Buffer	Operator Acceptance
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3.3.1 [REQ 16]	Number of unwanted Object Indications (NUOI)	Operator Acceptance
3.3.2 [REQ 17]	Object Indication Tracking Update Rate (OITUR)	$\geq 1$ Hz
3.3.3 [REQ 18]	Object Indication Tracking Update Rate (OITUR)	Operator specified
3.3.3 [REQ 18]	Position Renewal Time-out Period (PRTOP)	Operator specified
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3.4.1 [REQ 21]	Probability of PTZ Object Following Loss (POL)	Operator specified
3.4.1 [REQ 21]	Integrity Monitor Response Time (IMRT)	$\leq 10$ s
4.1.1 [REQ 22]	Integrity Monitor Response Time (IMRT)	$\leq 10$ s
4.1.1 [REQ 22]	Mean Time Between Critical Failures (MTBCF)	$\geq 20\,000$ hrs
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# Detection & Recognition Requirements Performance (DRRP)



# Detection & Recognition Range Performance (DRRP)

**TABLE 3: EXAMPLE MATRIX FOR CREATING AERODROME SPECIFIC DRRP**

ID	Area of Interest	Targets	Profile Size (m)	Range (m) for Detection (D) and Recognition (R)			
				Panorama		PTZ	
				D	R	D	R
[DRRP REQ 1]	Final Approach	Medium Aircraft	7.0 x 7.0 x 27,2				
[DRRP REQ 2]	Traffic Circuit	Light Aircraft	2.25 x 2.25 x 8.2				
[DRRP REQ 3]	Manoeuvring Area	Persons / Animals	1.8 x 0.5 x 0.5				
[DRRP REQ 4]	Manoeuvring Area	Vehicle	2.5 x 1.5 x 5.0				
[DRRP REQ 5]	Manoeuvring Area	Obstructions	0.3 x 0.3 x 0.3				
[DRRP REQ 6]	Apron	Light aircraft	2.25 x 2.25 x 8.2				
[DRRP REQ 7]	Apron	Obstructions	0.3 x 0.3 x 0.3				
[DRRP REQ 8]	Apron	Vehicle	2.5 x 1.5 x 5.0				
		Persons / Animals	1.8 x 0.5 x 0.5				

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	Mean Time Between Critical Failures (MTBCF)	$\leq 2$ hrs
	Mean Time To Repair (MTTR)	



# Study to investigate Lower Frame Rates in a Remote Tower Environment



DLR Remote Tower Field Test Platform  
at Braunschweig-Wolfsburg Airport

# What are the effects of low frame rates on:

- Physiological Stress
- Visual Detection Performance
- Perceived Video quality
- Perceived System operability

*Simulator Sickness Questionnaire (SSQ)  
by Kennedy, Lane et al. (1993)*

0%  100%

## A - Current Mental and Physiological State

The following 16 questions are designed to measure your current mental and physiological state. Please indicate how you **feel right now** by selecting your preferred answer amongst four possible choices. You can only select one answer per item. If you feel uncertain about the meaning of the items, just ask the experimenter.

	None	Slight	Moderate	Severe
General Discomfort	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fatigue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Headache	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eye Strain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulty Focusing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased Salivation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sweating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nausea	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulty Concentrating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fullness of Head	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blurred Vision	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dizzy (Eyes Open)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dizzy (Eyes Closed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vertigo (Vertigo is a disordered state in which the person or his/her surroundings seem to whirl dizzily)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stomach Awareness (Stomach awareness is usually used to indicate a feeling of discomfort which is short of nausea)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Burping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

# Physiological stress

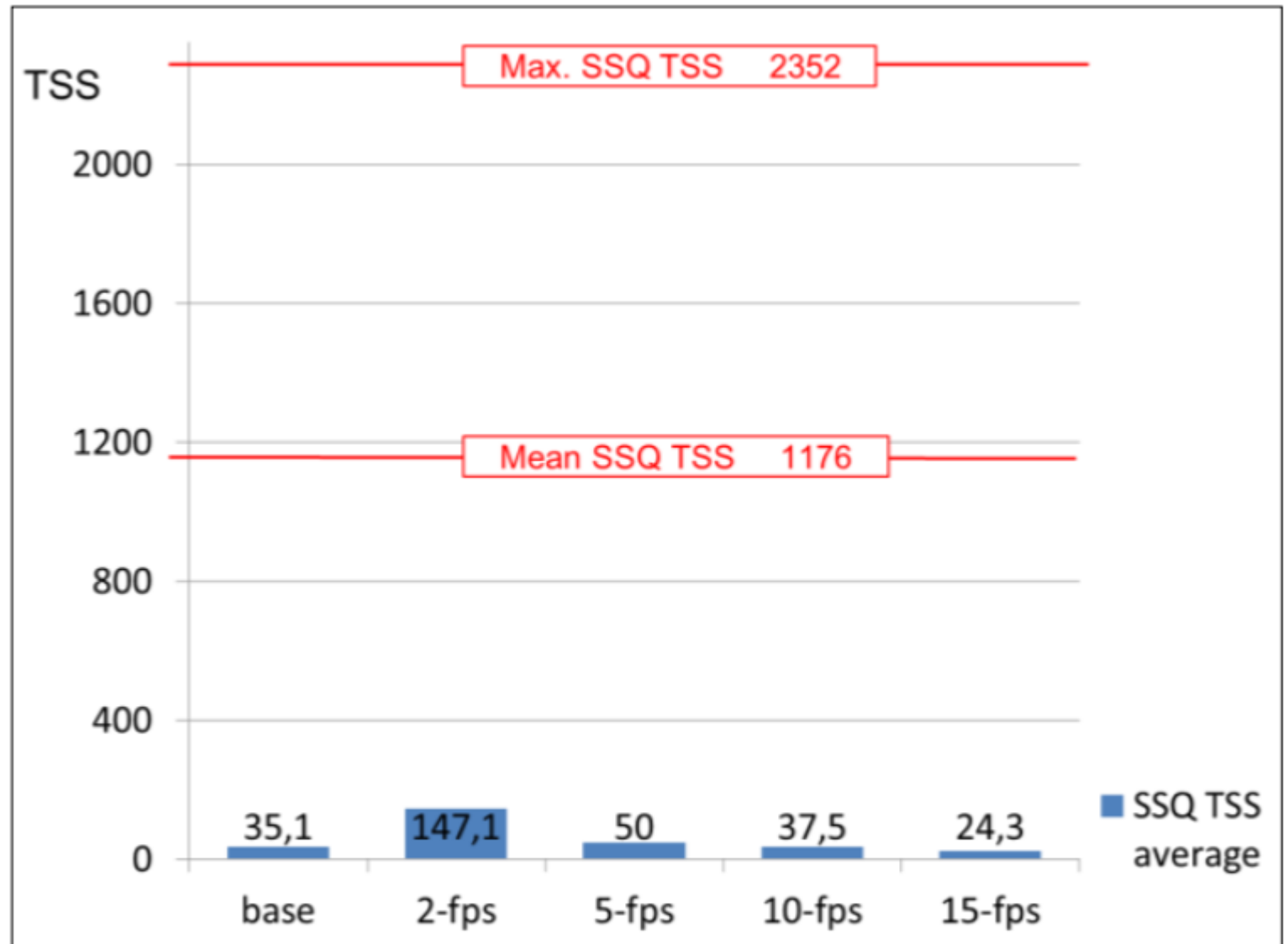


Figure 2. Total Sickness Scores before (base) and for four different FR test conditions.

## Conclusions

- Physiological stress not affected !
- Visual detection range performance unaffected
- Check blinking lights performance in < 5 fps conditions
- Preference for higher vs. lower frame rates
- Perceived Operability agreed for 5 /10 / 15 fps but not for 2 fps in this setting

*Full study results on*  
[www.remote-tower.eu](http://www.remote-tower.eu)



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# Box&Follow in a Visual Tracking Environment



	Object of interest	Object not of interest
Object tracked	<u>Wanted</u> → overtrust? → learnt carelessness	<u>Unwanted</u> → negative influence on acceptance, workload or Situation awareness?
Object not tracked	<u>Missed</u> → Safety critical?	<u>Correct Rejection</u>

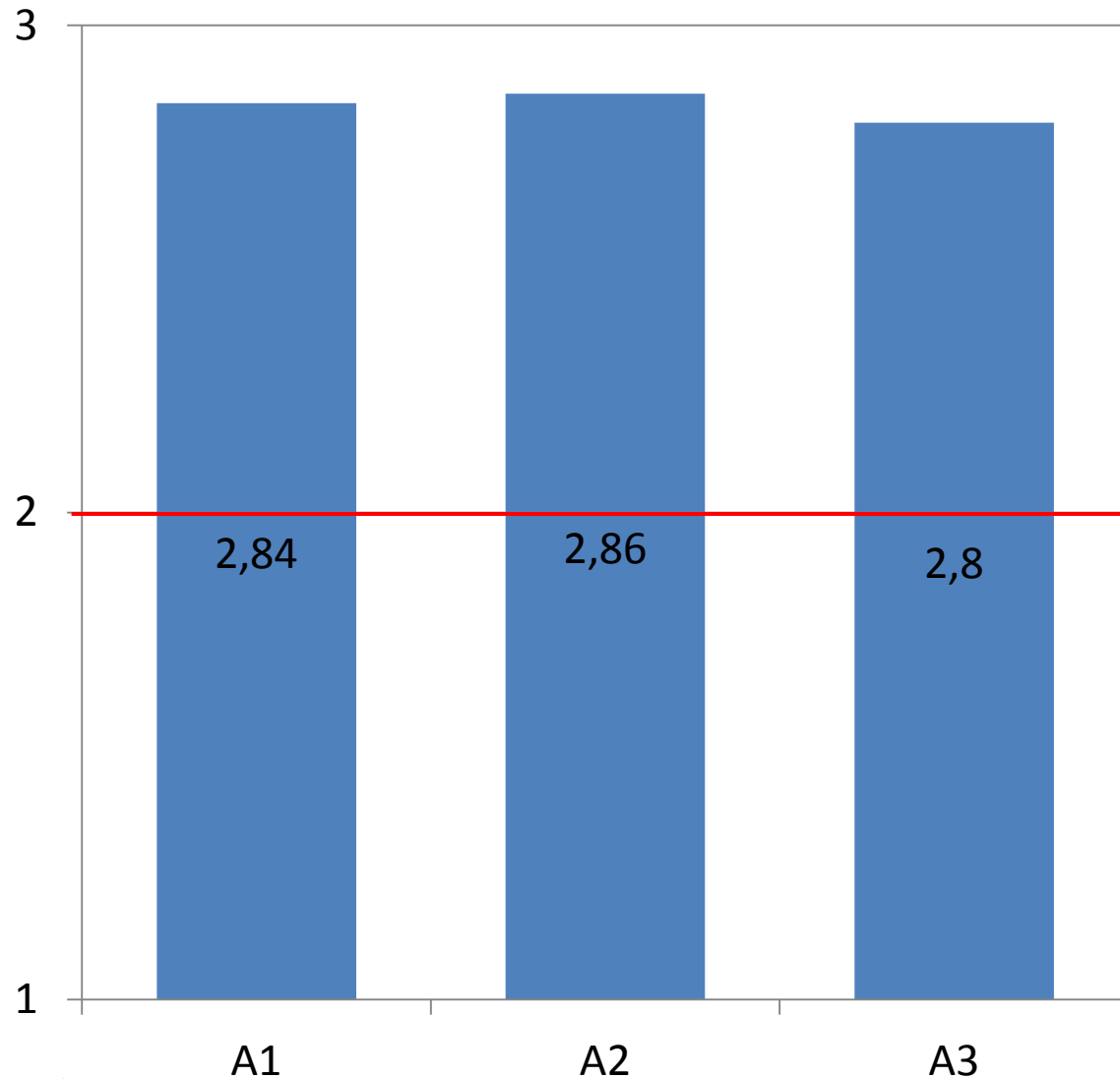
EUROCAE WG100 ED-240A in accordance to  
Signal Detection Theory (Wickens, 2002)

# Experimental Design

Location →	Runway				Taxiway				Final Approach				Traffic Pattern			
Dwell time ↓	BL	A1	A2	A3	BL	A1	A2	A3	BL	A1	A2	A3	BL	A1	A2	A3
30 sec	0	0	0	7	0	0	7	14	0	0	0	7	0	0	0	7
5 sec	0	0	7	14	0	7	14	28	0	7	7	14	0	7	7	14
2 sec	0	14	28	42	0	14	28	42	0	14	28	42	0	70	140	210



# Acceptance 3point Likert Scale (mid-run)



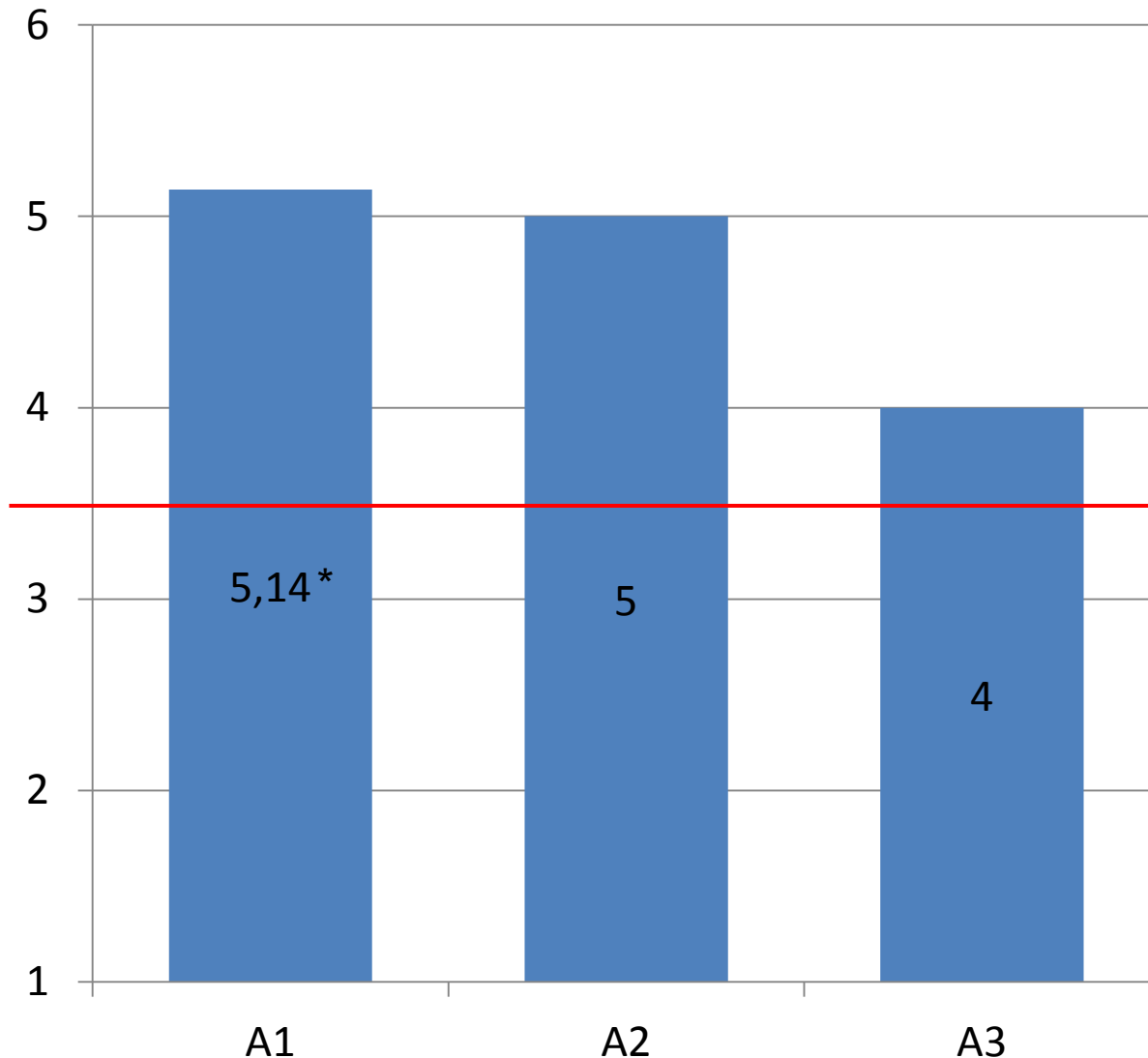
During the past 5 minutes I found the „Visual Tracking“:

3	2	1
Helpful	Not of interest	Disturbing

■ Acceptance of Tracking



# Acceptance (post-run) (unwanted)



I experienced unwanted Boxes (nuisance boxes) but they popped up in an acceptable amount that did not prevent me from working in a safe and efficient manner

Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
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■ Acceptance Post-run  
likert 1-6





# Maintenance Car detection

During a take-off it crossed without clearance

- Without tracking 4/7
- With tracking 7/7



# Conclusions

“Unwanted” Boxes disturb less than expected

Minimum performance value for “unwanted” hard to quantify

Visual Tracking is not a control tool – similar to non-cooperative radar information

Increase “hit” rate from 88% close to 100% on eventual costs of more “Unwanted” Boxes



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# PJ05



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### PJ05 Remote Tower for Multiple Airports



## Home

The modernisation of air traffic management is one of the main challenges of current aeronautics research. The **Single European Sky ATM Research (SESAR)** project defines, develops and deploys what is needed to increase ATM performance and build Europe's intelligent air transport system. The current programme is **SESAR 2020**, running from 2016 to 2024 with a budget of 1.6 billion Euro, supports projects to deliver solutions in four key areas, namely airport operations, network operations, air traffic services and technology enablers.

Part of **SESAR 2020** is the Project **PJ05 "Remote Tower for Multiple Airports"** with focus on the safe and efficient airport of the future. By bringing the concept of remotely controlling multiple airports to a higher maturity level, the **SESAR** project aims at providing small and medium sized airports with more cost-efficient and service tailored air traffic services.

The project was launched in November 2016 and runs in its first wave over 37 months supported by **39 international partners** from industry, air navigation



**That's how the future looks like...!?**

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