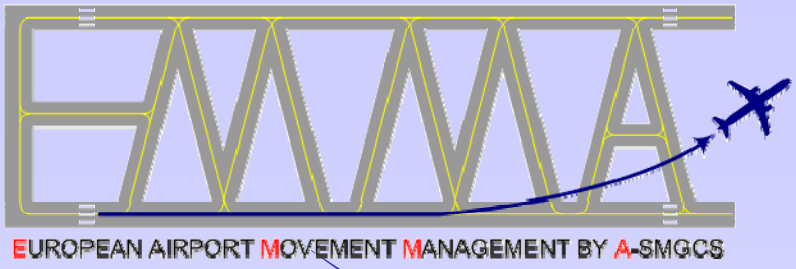

A-SMGCS Verification and Validation Results of the Project "EMMA"

Jörn Jakobi - DLR

ESAVS 2007, Bonn, 06 – 07 March 2007

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Integrated Project of the
Sixth Framework Programme,
Priority 1.4:
Aeronautics and Space,
sponsored by EC, DG TREN
Contract FP6-503192

EMMA overview

A-SMGCS EU-Projects

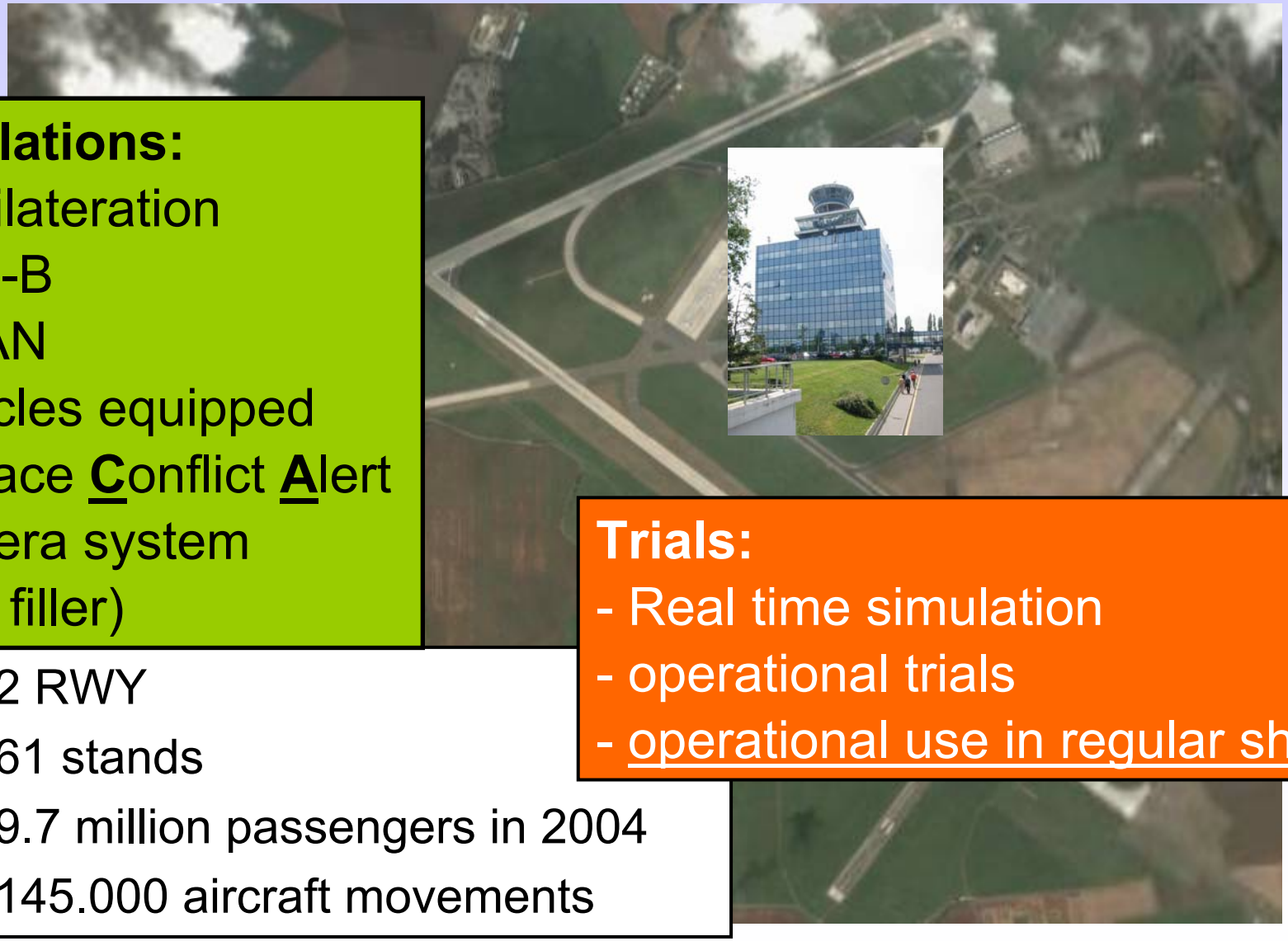
EU-Project		Results	Duration	FP
DETAMM	**De**monstration **F**acilities for **A**irport **M**ovement **M**anagement	**Technology evaluation** and demonstration	1996-1999	
BETA	Operational **B**enefits **E**valuation by **T**esting **A**-SMGCS	**Benefits shown** in operational field trials in **Input to ICAO** Doc 9830. Industry products matured.	2000-2002	
EMMA	**E**uropean airport **M**ovement **M**anagement by **A**-SMGCS Part **2**	• A-SMGCS level 1&2 **concept validated** through operational field trials • **Performance data** for ICAO doc 9830	2004-2006	
EMMA2		• Definition of **A-SMGCS higher services** (CPDLC, Planning, …) in performance based approach • Validation in simulation and **field trials**	2006-2008	

24 Partners

(in alphabetical order)

Aena – Aeropuertos Españoles y Navegación Aérea	AIRBUS	Řízení letového provozu České republiky, s.p. – Air Navigation Services of the Czech Republic	Athens University of Economics and Business
AVIATION HAZARD ANALYSIS – ATC Safety and Capacity Consultans	BAE SYSTEMS	DFS Deutsche Flugsicherung	dgac – DSNA
DIEHL Aerospace	DLR	ENAV S.p.A. – SOCIETÀ NAZIONALE PER L'ASSISTENZA AL VOLO	ERA – RADAR TECHNOLOGY
EUROCONTROL	EuroTelematik	Messier-Dowty – snecma group	NLR
Park Air Systems	Prague Airport	SELEX Sistemi Integrati – A Finmeccanica Company	Sicta
sofréavia – a groupe egis company	STAR ALLIANCE – The airline network for Earth.	THALES	TECHNISCHE UNIVERSITÄT DARMSTADT

Prague Ruzyne



Installations:
- Multilateration
- ADS-B
- DMAN
- vehicles equipped
- **S**urface **C**onflict **A**lert
- camera system (gap filler)

- 2 RWY
- 61 stands
- 9.7 million passengers in 2004
- 145.000 aircraft movements

Trials:
- Real time simulation
- operational trials
- operational use in regular shift

Toulouse Blagnac

Trials:
Shadow mode trials

Installations:
- Multilateration
- ADS-B
- **S**urface **C**onflict **A**lert
- vehicles equipped

- 2 RWY
- 28 stands
- 5.6 million passengers in 2004
- 95.000 aircraft movements

Milan Malpensa

Trials:
Real time simulation
Shadow mode trials

Installations:
- Multilateration
- **S**urface **C**onflict **A**lert
- ADS-B
- vehicles equipped (M-LAT, WLAN)

- 2 RWY
- 115 stands
- 17.6 million passengers in 2003
- 213.000 aircraft movements

Performance driven approach using different test platforms

- Real time simulation
  - to initially check the operational feasibility,
  - to evaluate the potential for operational improvements,
  - to assess new functions in safety critical situations.
- Field trial setups are integrated
  - to check the feasibility of alternative technological options,
  - to check the applicability to diverse airport environments,
  - to prove the operational feasibility in real life conditions.
- EMMA results and conclusions
  - add, modify and abandon requirements in A-SMGCS standards,
  - validate the A-SMGCS concept.

Field test platforms

GA Aircraft

Test Aircraft

Research Aircraft

Research Test Van

Paris CDG
(Data analysis)

Toulouse Blagnac

Prague Ruzyne

Milano Malpensa

Simulation platforms

Airbus Cockpit

Thales Cockpit

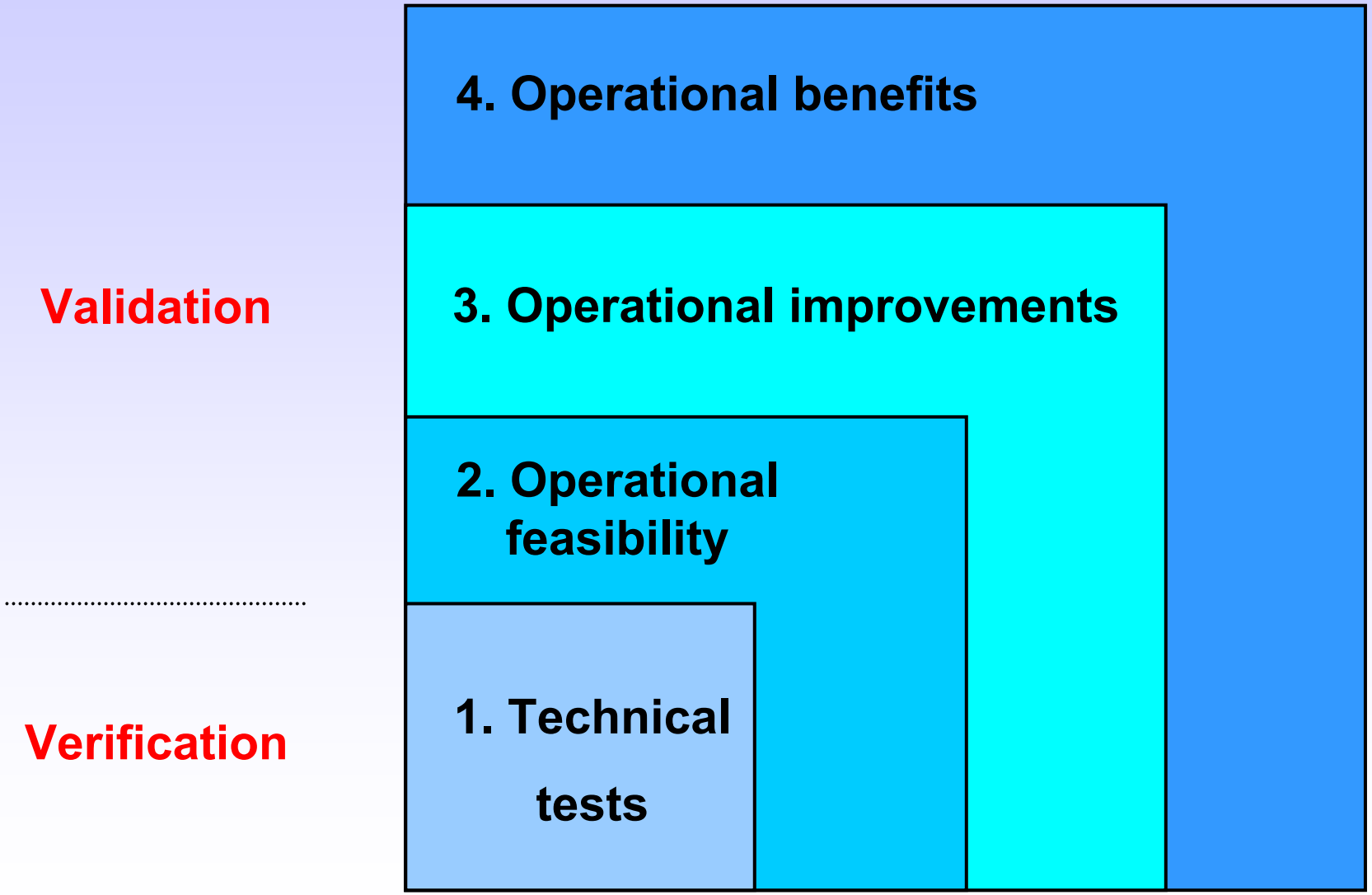
DLR Cockpit

TU-D Cockpit

NLR Tower

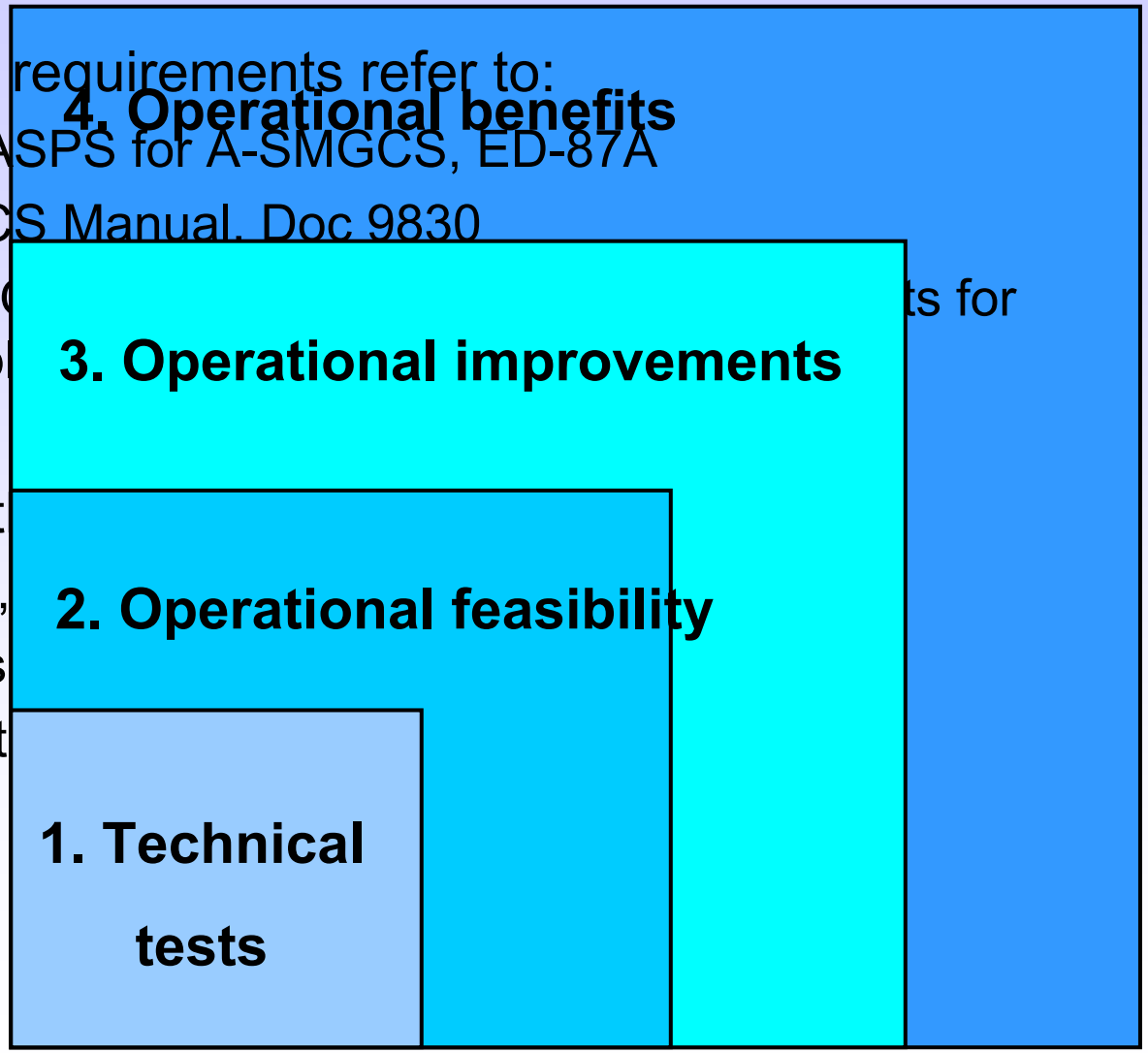
DLR Tower

EMMA V&V methodology



Verification

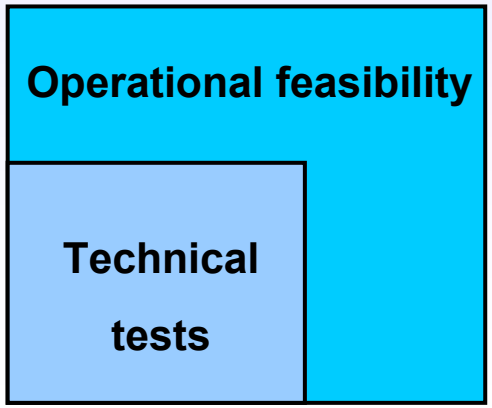
- EMMA technical requirements refer to:
  - EUROCAE MASPS for A-SMGCS, ED-87A
  - ICAO A-SMGCS Manual, Doc 9830
  - EUROCONTR ts for A-SMGCS imp
- But improved wit
  - new indicators,
  - long-term tests
  - more clear test



Validation

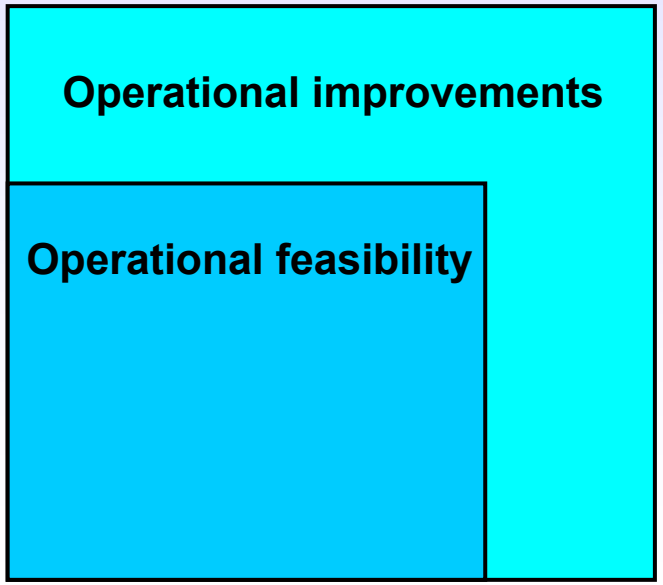
- “Is the technical performance sufficient to cover the needs of the users?”

- Assessment via
  - questionnaires - “Can you work with the new system properly?”



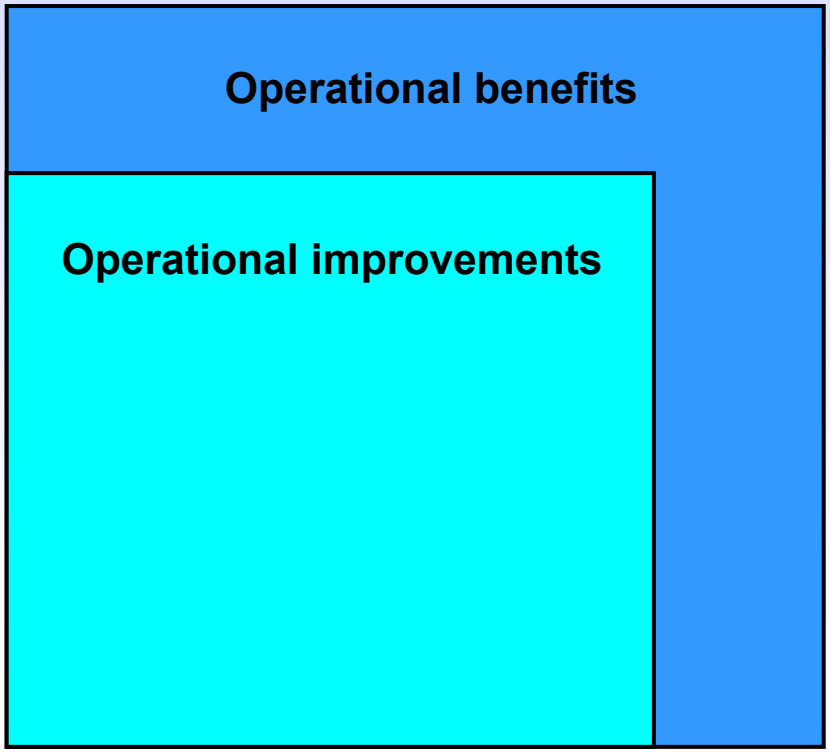
Validation

- “Yes, we can work with the new system properly, but does it improve something?”
- Key performance areas
  - safety,
  - efficiency (incl. capacity, environment),
  - human factors.



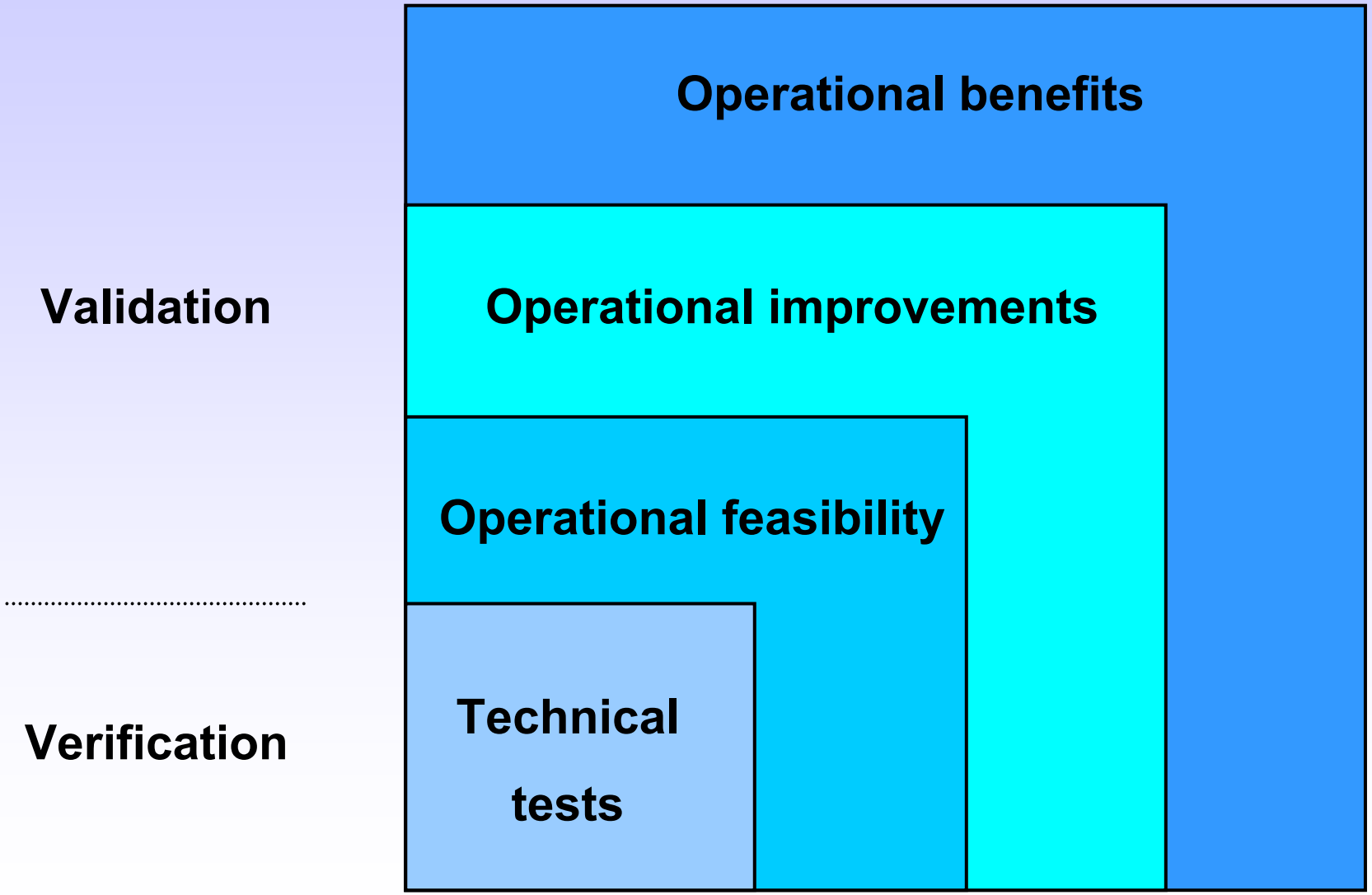
Validation

- “Oh yes, we can work safely and more efficient, but how many Euros do we save?”



EMMA results

Validation methodology



Short-term

Performance requirement	Required	Short-term Measured
Reported position accuracy	≤ 7.5 m	3.2 m – 7.5 m
Probability of detection	**≥ 99.90%**	**99.65% – 99.98%**
Probability of false detection	≤ 0.001%	0% – 0.070%
Probability of identification	≥ 99.90%	99.72% – 100%
Probability of false identification	≤ 0.001%	0%
Target report update rate	≤ 1s	0.47s – 1s
Probability of detection of an alert situation	≥ 99.9%	100%

Problems with current technical tests

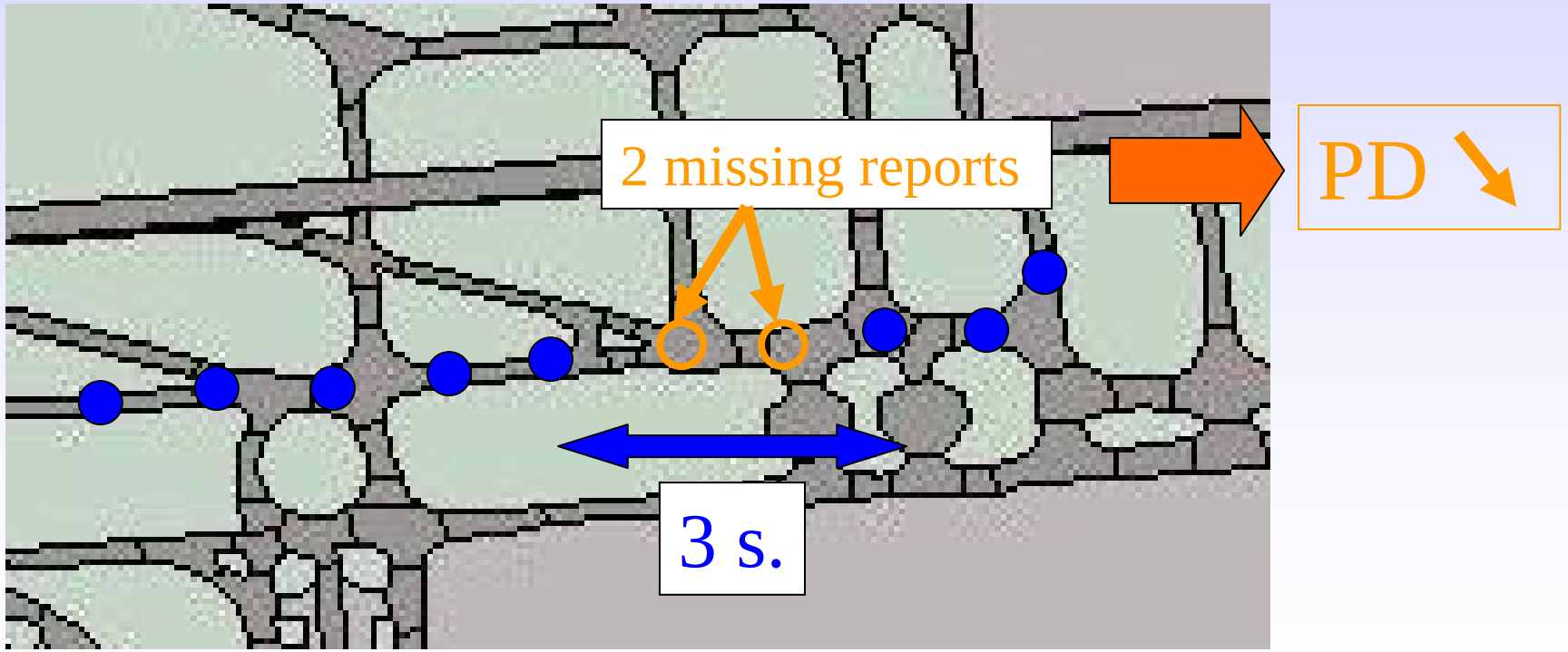
- How to ensure that the performances are **stable**?
- How to take into account the whole **traffic mix** (equipped/not equipped aircraft/vehicle)?
- How to assess the performances during **adverse environmental conditions** (strong rain, snow, long grass)?
- Did we distinguish different airport areas rwy, twy, apron, approach
- How to assess the performances in a **non intrusive** way?

MOGADOR

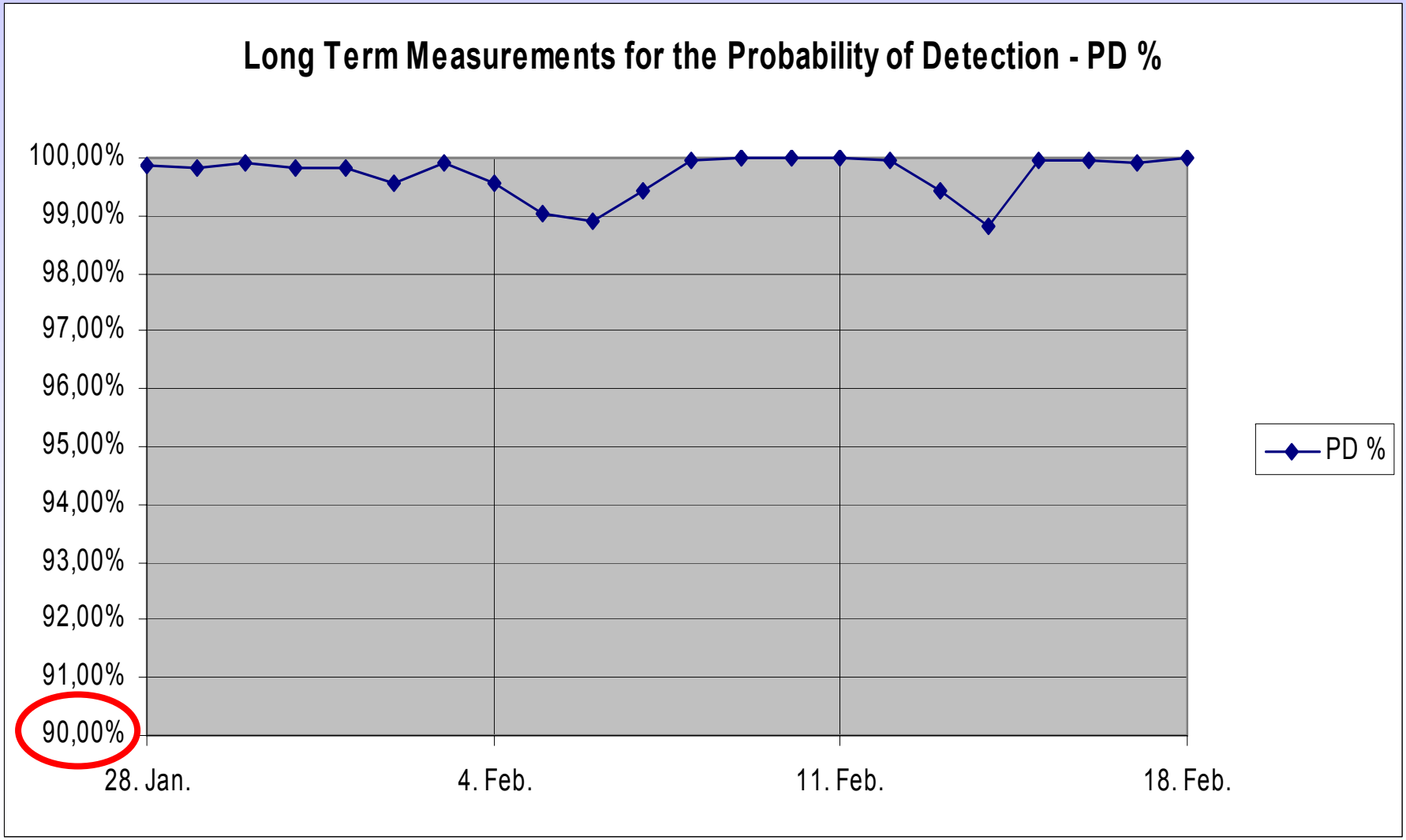
- Automatic long-term system performance assessment tool
- The path reconstruction algorithm uses surveillance data (position, identification) to rebuild a geographically and temporally consistent trajectory for each movement.
- It is based on the topological description of the manoeuvring area
- Significant events are recorded in a database
  - Mising, false or unwanted reports,
  - Missing or false ID,
  - of vehicles, aircraft or unknown movements
  - Etc.

Long-term

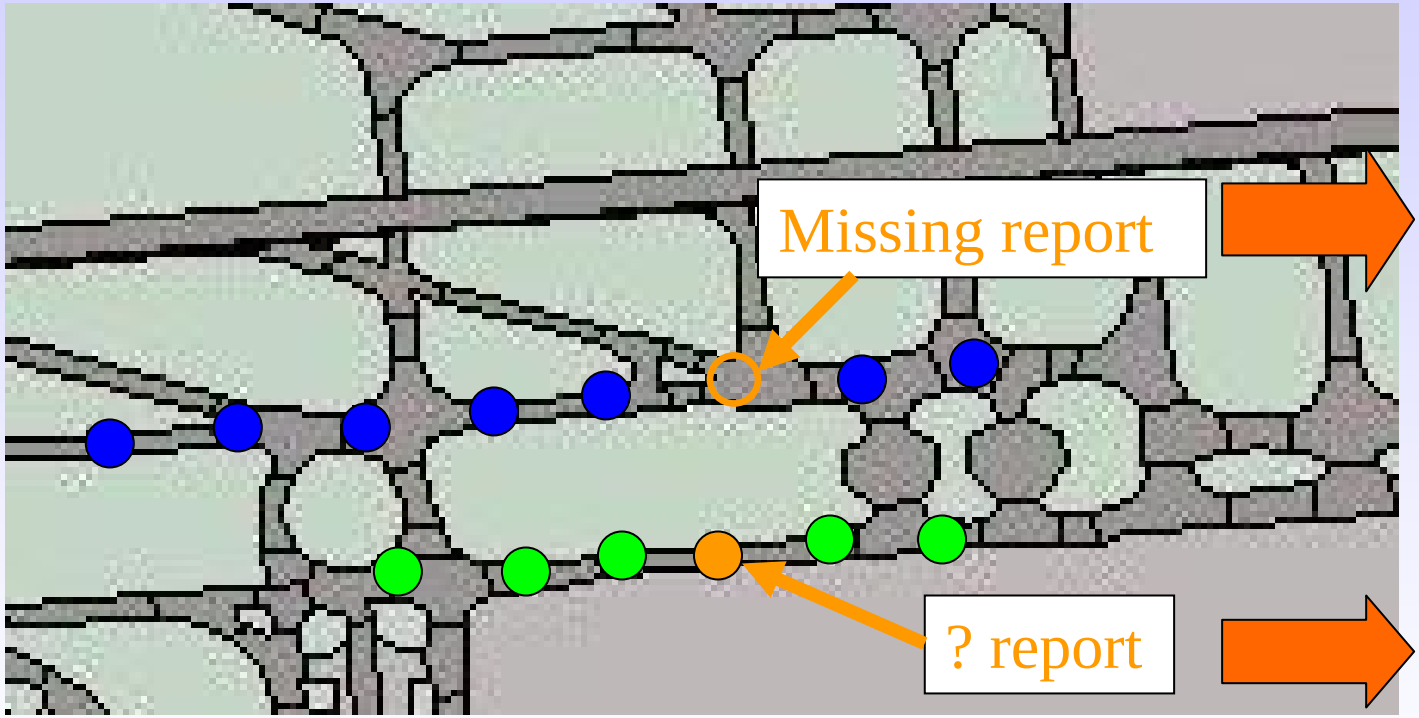
- A software, MOGADOR, has been matured in EMMA to continuously assess the performances of the surveillance function



Technical performance monitoring



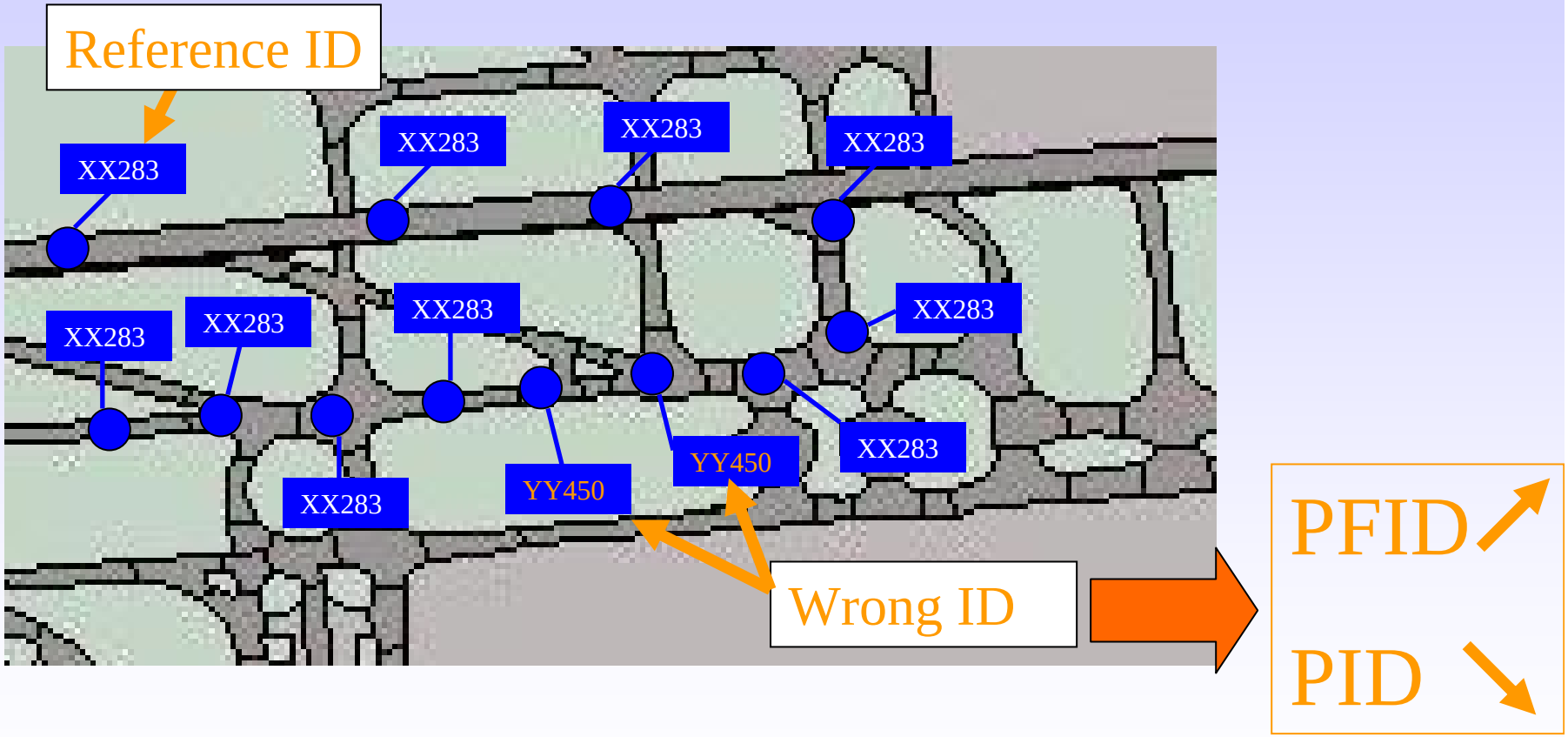
MOGADOR principles :
False reports



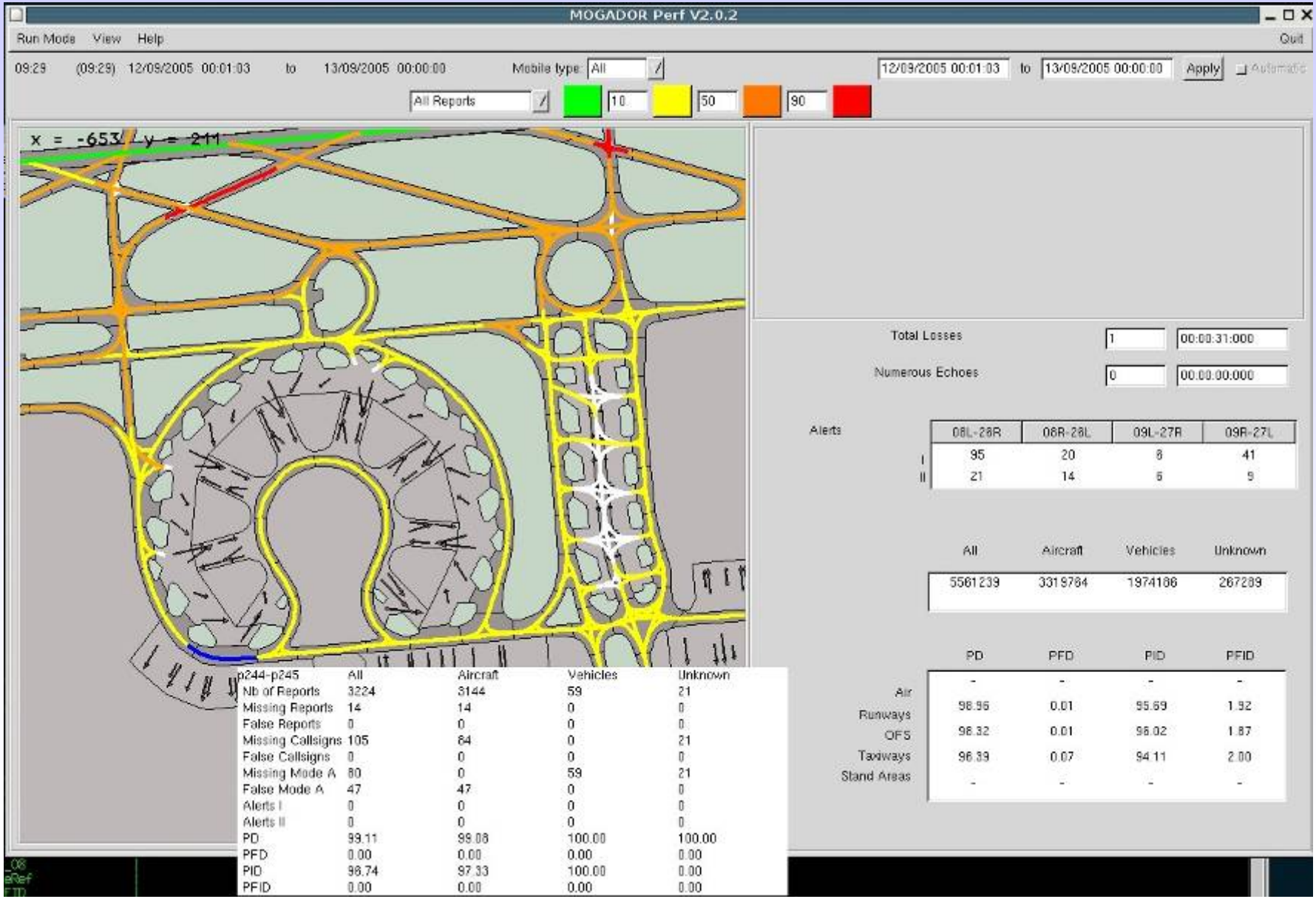
PD ↘

~~PFID~~ ↗
PFD ↗
PID ↘

MOGADOR principles :
Wrong ID



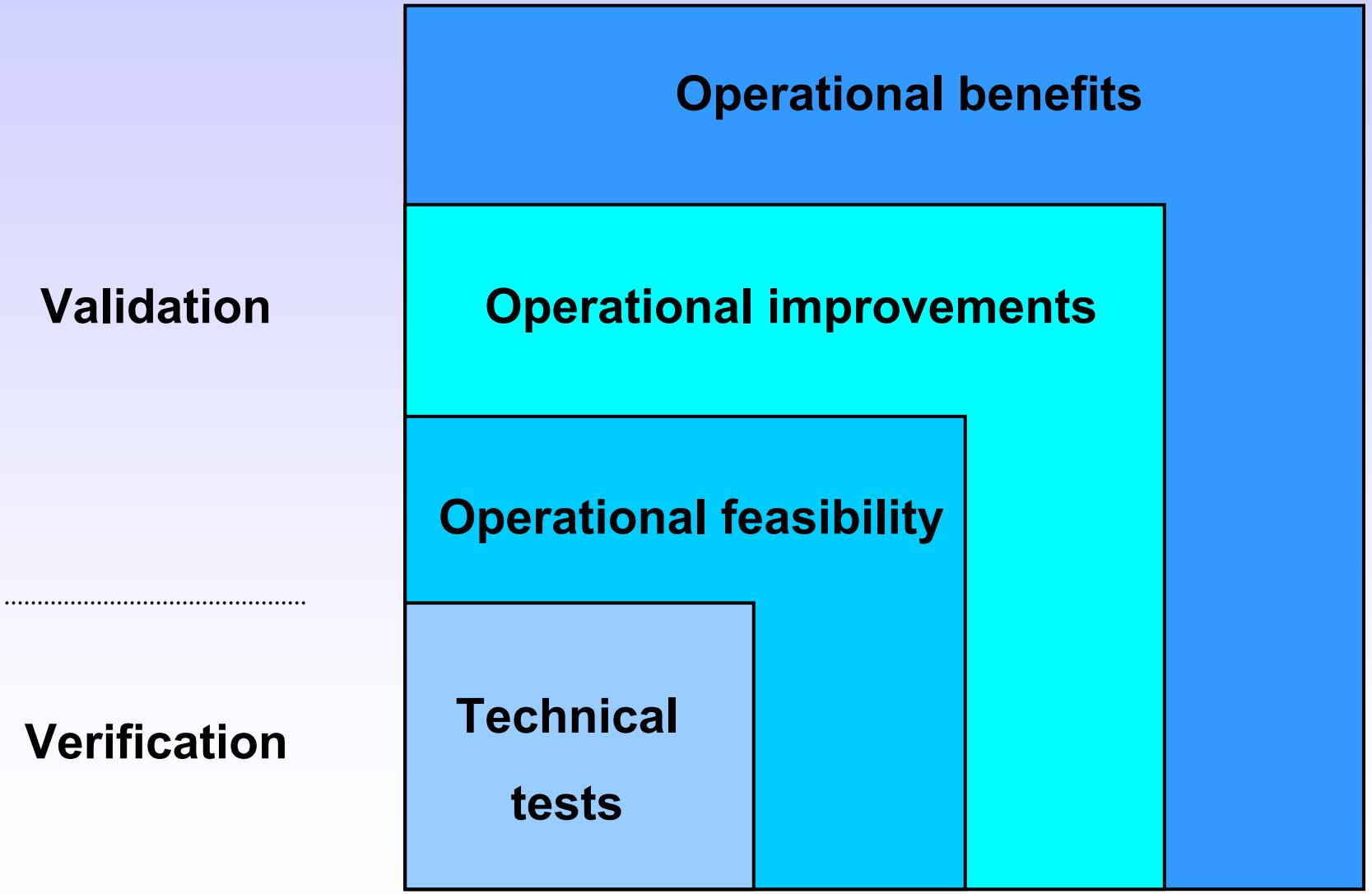
MOGADOR HMI


MOGADOR Perf V2.0.2
Run Mode
View
Help
Quit
09:29
(09:29) 12/09/2005 00:01:03
to
13/09/2005 00:00:00
Mobile type
All
12/09/2005 00:01:03
to
13/09/2005 00:00:00
Apply
Automatic
All Reports
10
50
90
x = -653 y = 211
Total Losses
1
00:00:31:000
Numerous Echoes
0
00:00:00:000
Alerts
08L-26R
08R-26L
09L-27R
09R-27L
I
95
20
8
41
II
21
14
6
9
All
Aircraft
Vehicles
Unknown
5561239
3319784
1974186
267289
PD
PFD
PID
PFID
Air
-
-
-
-
Runways
98.96
0.01
95.69
1.92
OFS
98.32
0.01
96.02
1.87
Taxiways
96.39
0.07
94.11
2.00
Stand Areas
-
-
-
-
p244-p245
All
Aircraft
Vehicles
Unknown
Nb of Reports
3224
3144
59
21
Missing Reports
14
14
0
0
False Reports
0
0
0
0
Missing Callsigns
105
84
0
21
False Callsigns
0
0
0
0
Missing Mode A
80
0
59
21
False Mode A
47
47
0
0
Alerts I
0
0
0
0
Alerts II
0
0
0
0
PD
99.11
99.08
100.00
100.00
PFD
0.00
0.00
0.00
0.00
PID
98.74
97.33
100.00
0.00
PFID
0.00
0.00
0.00
0.00

MOGADOR : results and lessons learned

- MOGADOR has been successfully validated and used in Paris CDG
- EMMA succeeded to harmonise the algorithm to measure the A-SMGCS performance on a long-term basis
- however, when using MOGADOR, the tool has to be adapted to the specialities of each new airport (airport topology, update rates, etc.)

Validation methodology

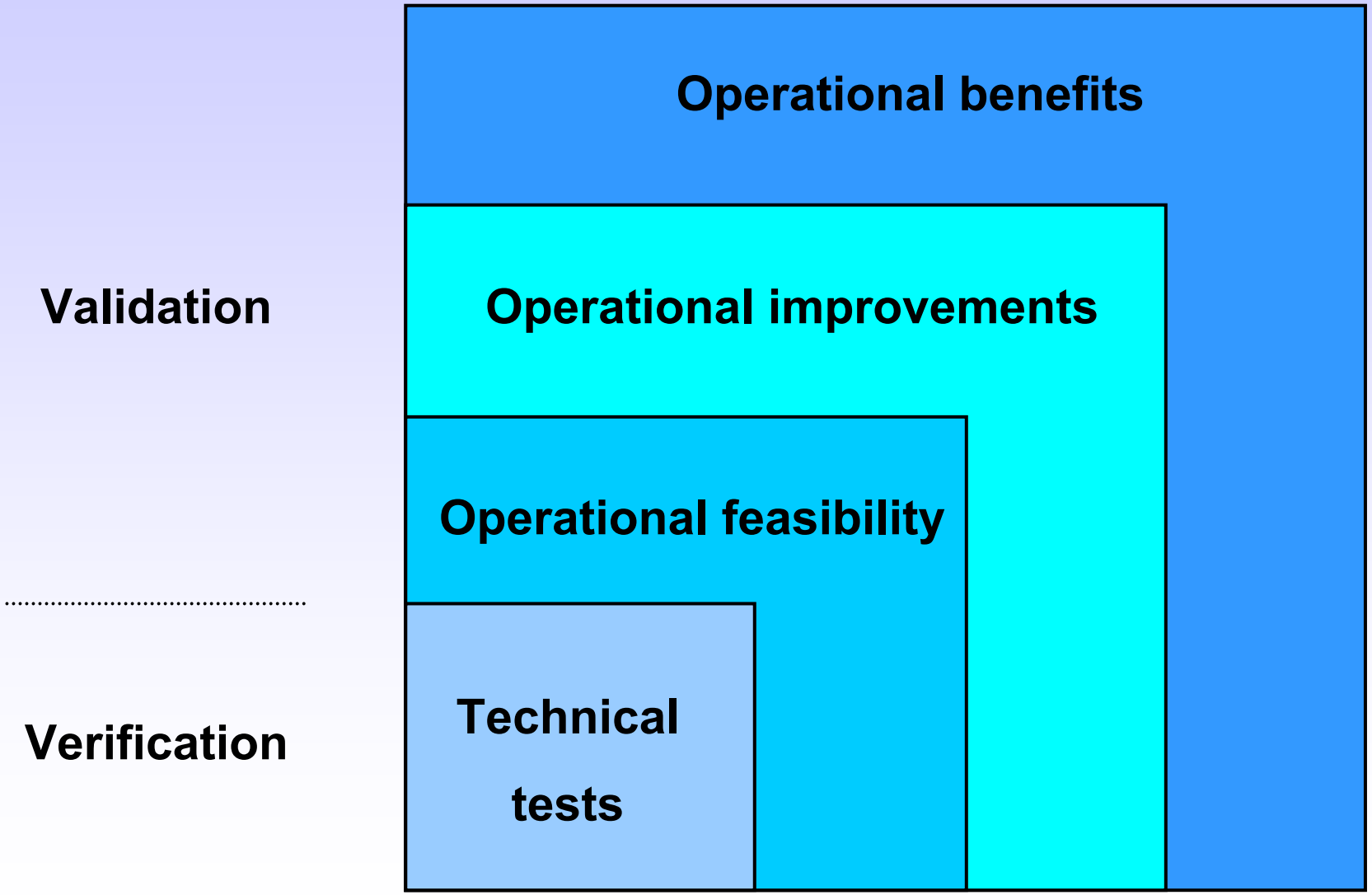


Examples of debriefing questions – field trials Prague

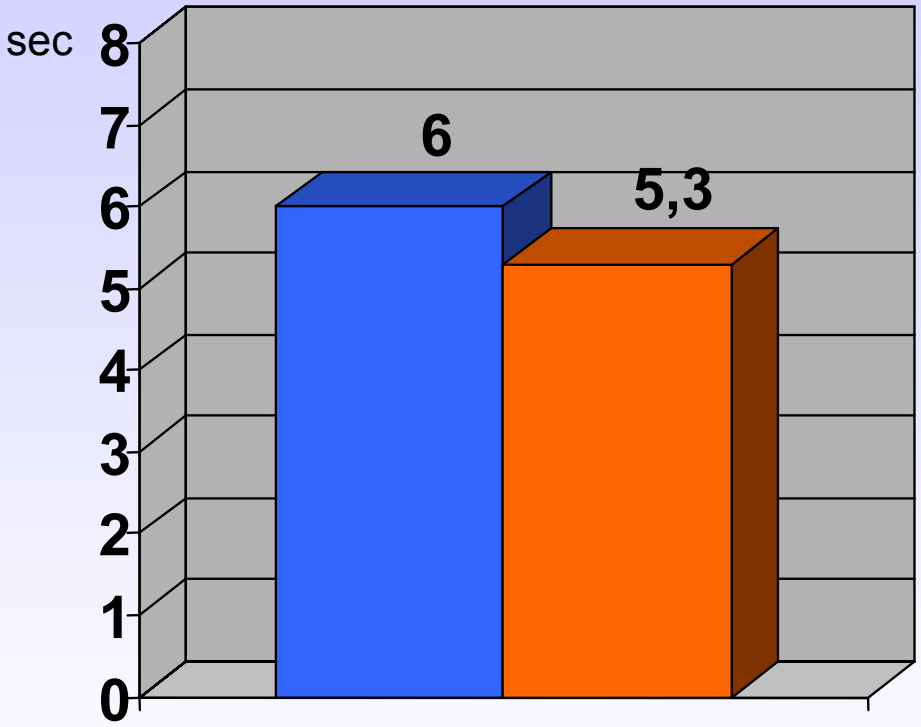
Nr.	Item	Mean	P
VA-3	When visual reference is not possible, the displayed position of the aircraft on the taxiways is accurate enough to exercise control in a safe and efficient way.	5,4	0,00*
VA-6	When visual reference is not possible, a wrong label is not a problem to exercise control in a safe and efficient way.	1,9	0,00*
VA-22	I experienced that aircraft have failed to comply with the transponder operating procedures.	4,7	0,00*
VA-…	…	…	…

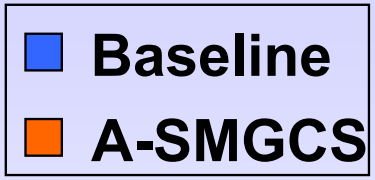
One-Sample T-Test expected mean value = 3,5, answers from 1 (disagreement) to 6 (agreement), N = 15 ANS_CR controllers, α = 0.05

Validation methodology



Real-time simulation





ATCO reaction time in case of conflict (sec)

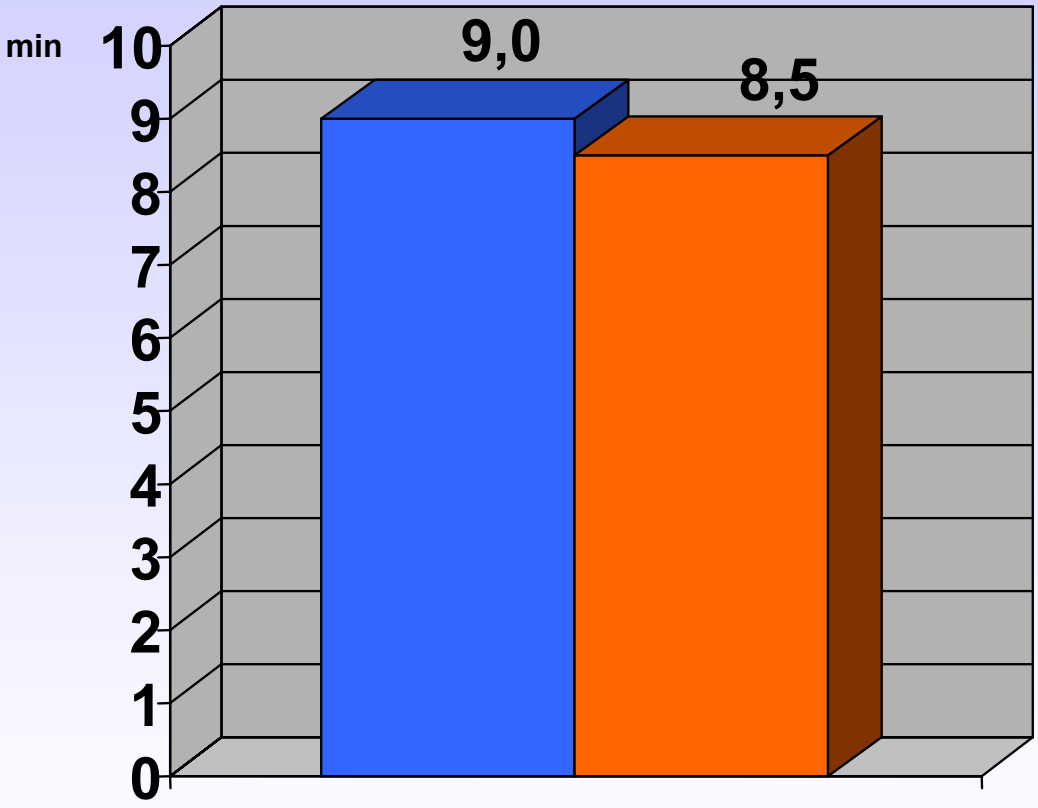
difference: 0,69 sec

df: 12

t-value: -0,56

p-value: 0.28 (not significant)

Real-time simulations



mean taxi time (min)

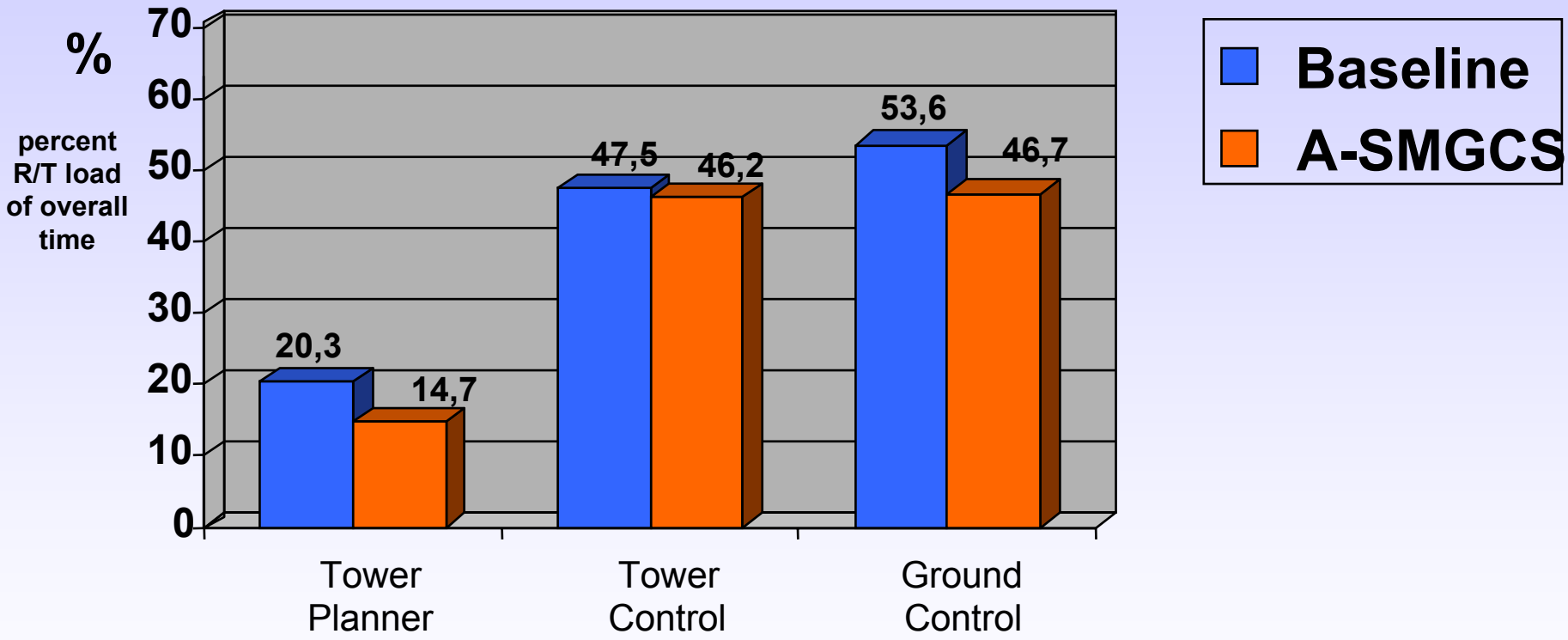
difference: -30 sec

df: 178

t-value: -1,973

p-value: 0.03* (significant)

Real-time simulations



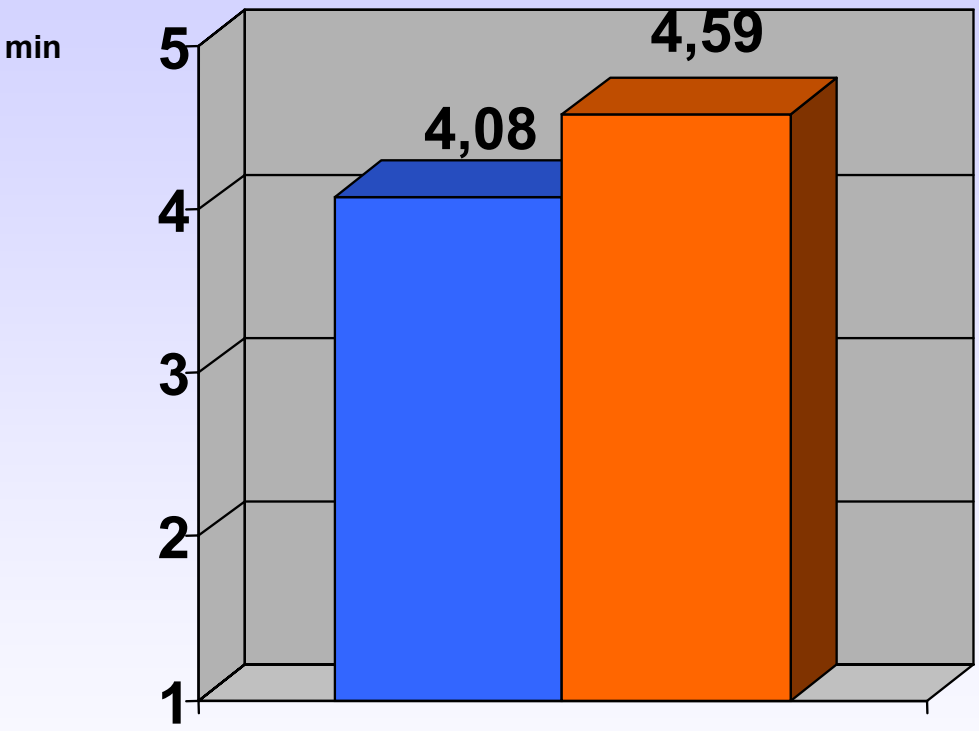
R/T communication

df: 1

F-value: 3,675

p-value: 0.06 (not significant)

Real-time simulations



difference: 0,51

df: 10

T-value: 2,965

p-value: **0.01***

situation awareness

(SASHA Q Item 12)

Operational field trials

VA	Safety	Mean	P
VA-28	When procedures for LVO are put into action, A-SMGCS helps me to operate safer.	5,4	0,00*
VA-50	A-SMGCS is helpful for better monitoring aircraft commencing its take off roll.	4,7	0,02*
VA-61	I think A-SMGCS can help me detect or prevent runway incursions.	5,0	0,01*
VA-…	…		

Operational field trials

VA	Efficiency / capacity	Mean	P
VA-9	When visual reference is not possible, I think **identifying** an aircraft or vehicle is more efficient when using the surveillance display.	5,2	0,01*
VA-10	I think, also in good visibility conditions, **identifying** an aircraft or vehicle is even more efficient when using the surveillance display.	5,2	0,00*
VA-122	The A-SMGCS enables me to handle more traffic when visual reference is not possible.	4,3	0,01*
VA-…			

Operational field trials

VA	Human factors	Mean	P
VA-125	The A-SMGCS helps me to improve my **situation awareness**.	5,1	0,00*
VA-59	When procedures for LVO are put into action, A-SMGCS helps me to reduce my **workload**.	5,2	0,00*
VA…	….	…	…

EMMA Recommendations w.r.t. surveillance 1/2

a) include a/c type specific procedures in the checklists and in the aircraft operations manual to further improve pilots' compliancy to the transponder operating procedures

b) A-SMGCS surveillance display as a primary means for identification.

c) all aircraft and vehicle movements, which intend to use the manoeuvring area, should be properly equipped to be co-operative with an A-SMGCS.

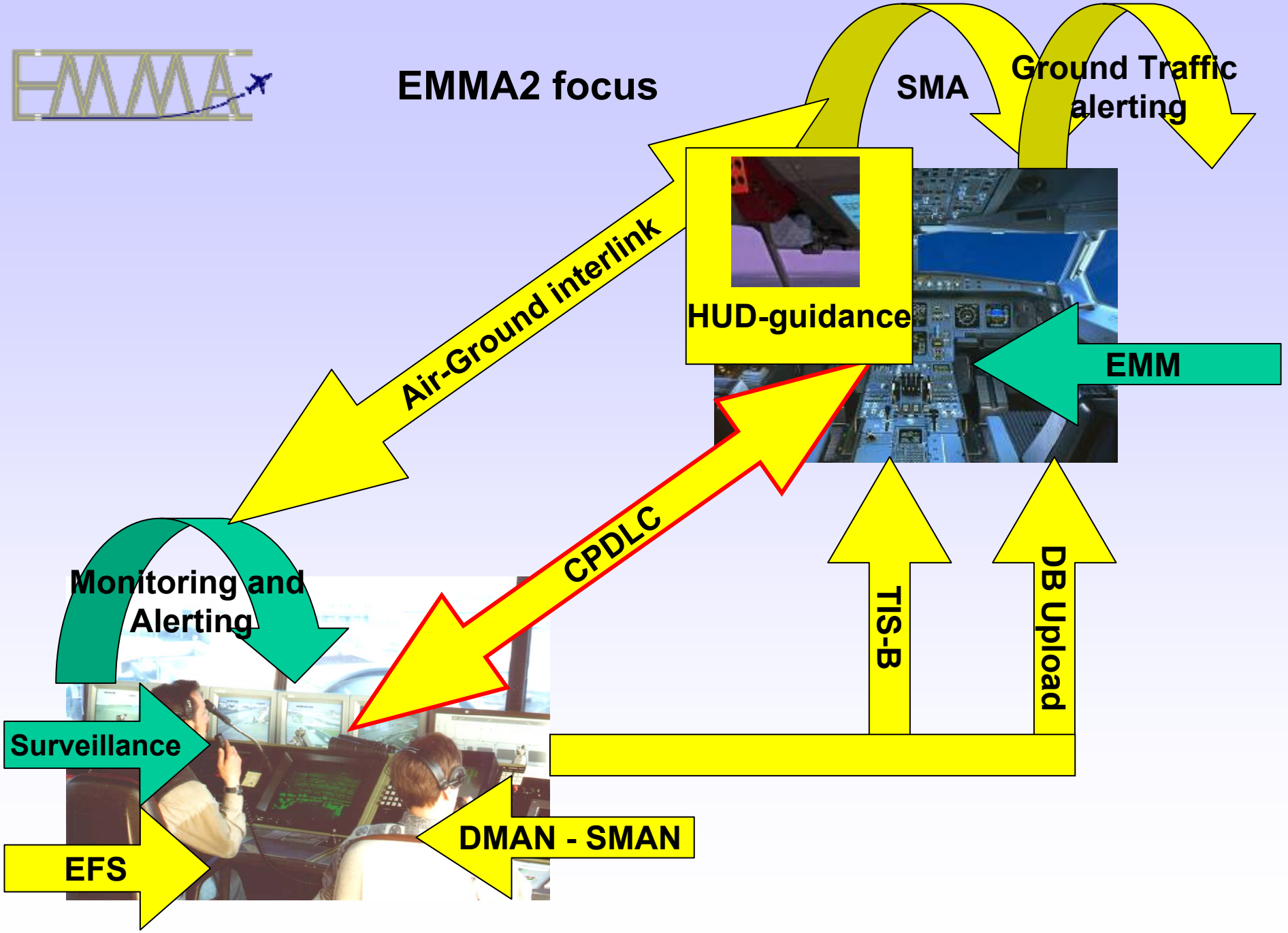
EMMA Recommendations w.r.t. surveillance 2/2

d) Implementing A-SMGCS requires intensive adaptation (tuning) to obtain a sufficient and reliable system performance.

e) Some performance requirements needs continuous long-term observation over a period of several weeks. Automatic assessment tools, like the MOGADOR tool used in EMMA, may help here.

EMMA2 overview

EMMA2 focus


SMA
Ground Traffic alerting
Air-Ground interlink
HUD-guidance
EMM
CPDLC
TIS-B
DB Upload
Monitoring and Alerting
Surveillance
EFS
DMAN - SMAN

Contact

http://www.dlr.de/emma/

http://www.dlr.de/emma2/