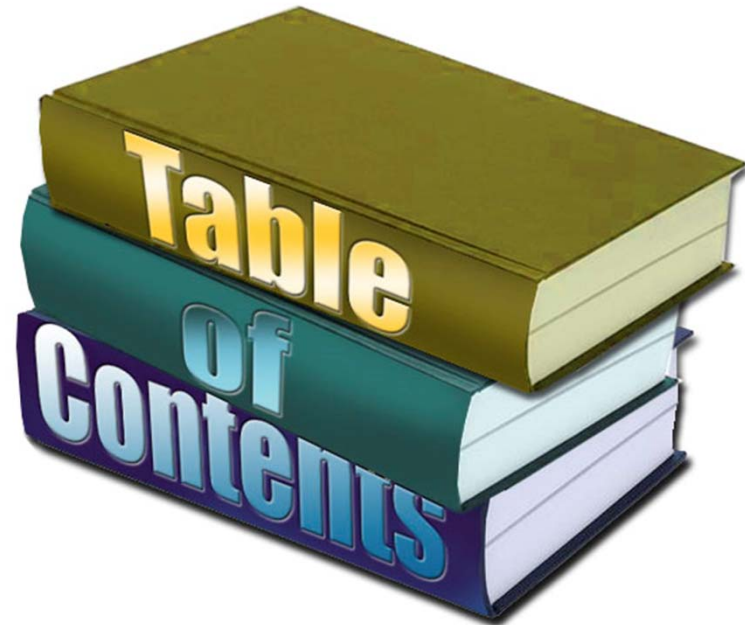# The Impact and Use of Simulation in Airport Operations

Dutch Benelux Simulation Society
TU Delft

Alan Marsden

EUROCONTROL Project Manager

18 November 2016

Content

- Operational Context

- EUROCONTROL airport simulation capability

- Simulations with partner airports

- Developing future concepts through simulation

- Football !

Total Airport Management – TAM

APOC

Manage performance

MET

Integration of data

Integration of landside processes

AOP

Monitor performance

DCB

Arrive & depart to plan

Integration of de-icing processes

Why the need to modernise ATM ?

Congestion
In Europe:
30,000 flights per day
5,000 aircraft

Fragmentation
41 EUROCONTROL
Member States

Efficiency
Congestion & delay have
an economic impact

Environment
Aviation accounts for 3%
of global emissions

Old Technology
Radio invented in 1920s

Safety
Flight volume
will double by 2030

What are the problems for airports?

Airport processes are mostly independent from the Network

Poor predictability of operations

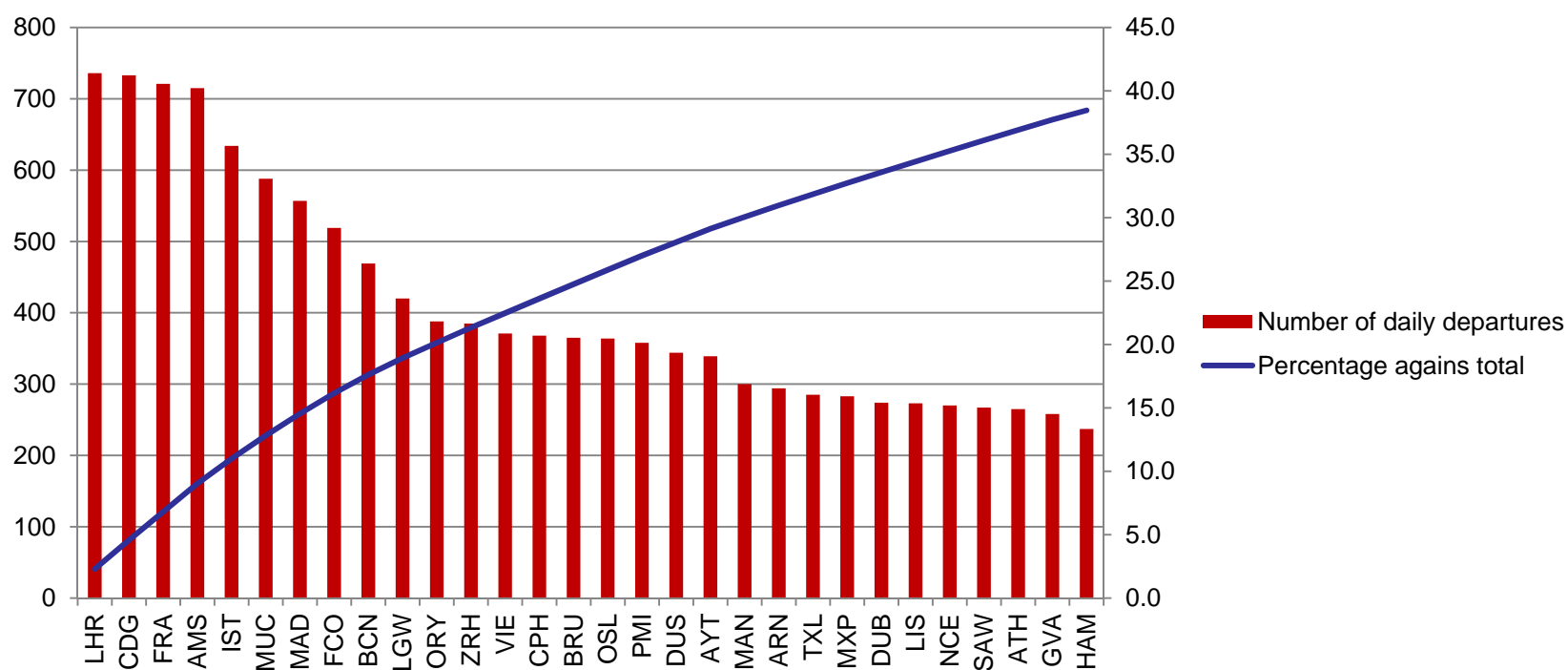Restrictions are needed to balance traffic flow

Increasing block times

Poor communication between stakeholders

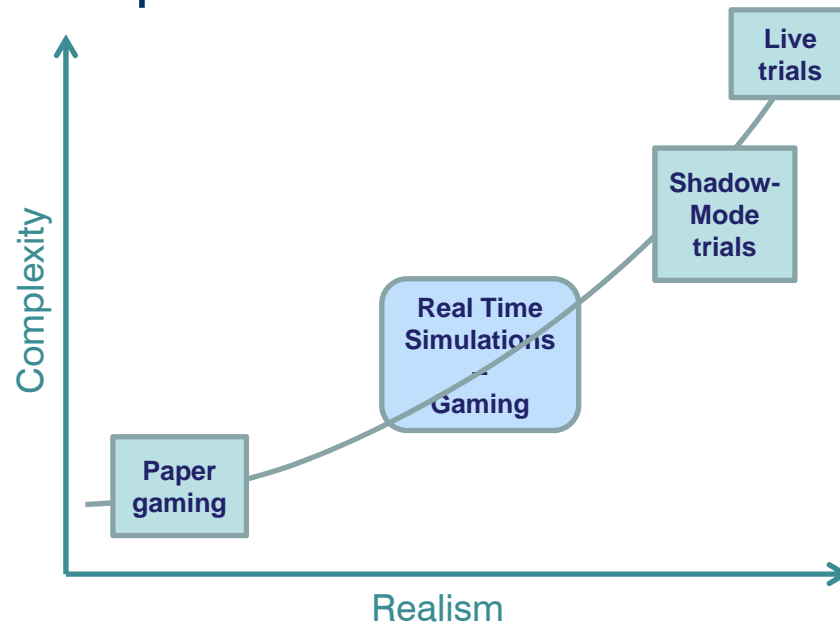Decreasing efficiency of Airport resources

Why are airports important to Network Performance ?

Looking at the top 30 airports by number of departures, we see that 40%
of all European flights are departing from one of these airports

Monday 07 July 2014

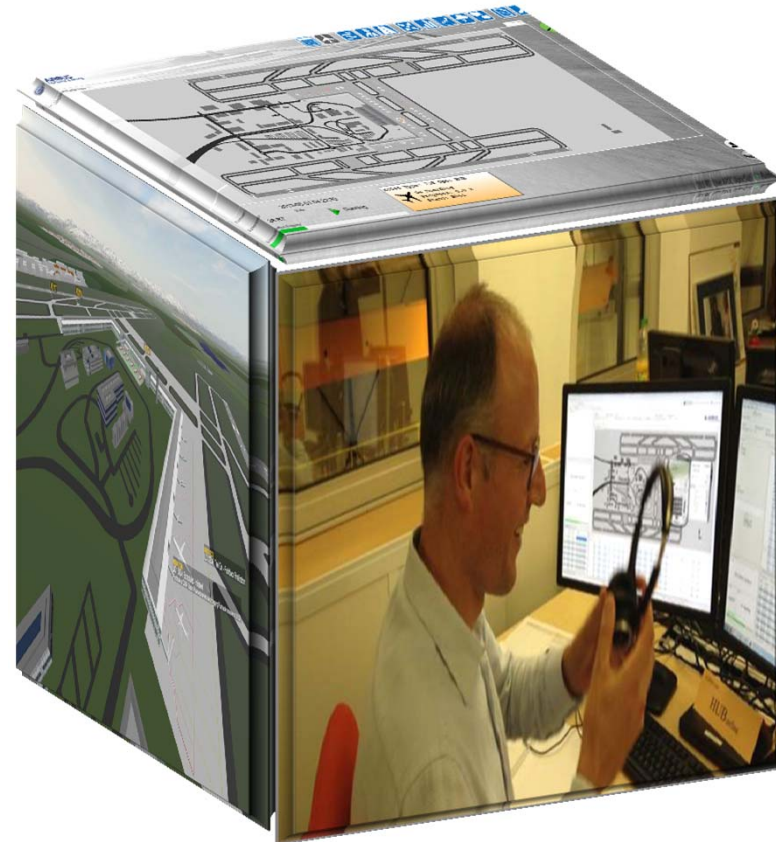# EUROCONTROL's approach to simulation with our partners

The EUROCONTROL Airport Operations Centre Validation Platform
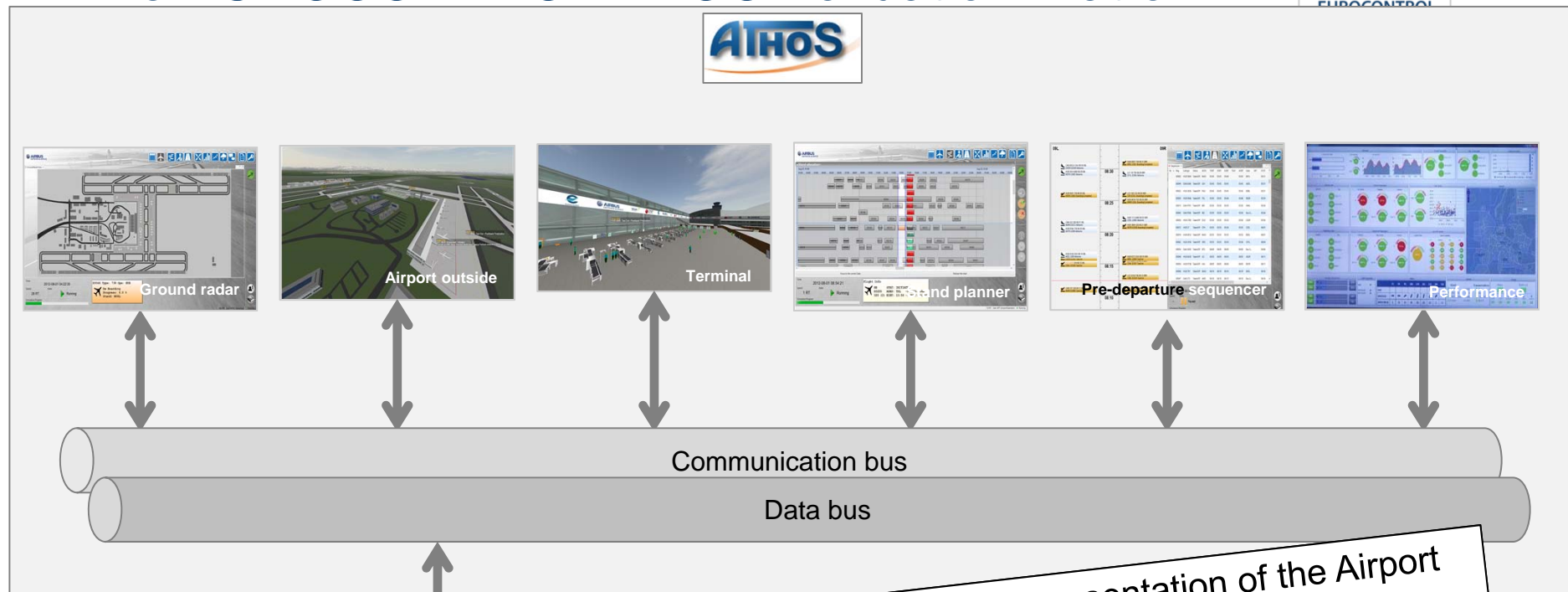
Bringing together :
- One airport simulator
- One user interface

And creating :
- An ultra-realistic man-in-the-loop validation platform

The EUROCONTROL APOC Validation Platform

ATHOS

| Ground radar | Airport outside | Terminal | Ground planner | Pre-departure sequencer | Performance |

Communication bus

Data bus

CAST SIMULATION

- High fidelity representation of the Airport Operation Plan;
- Configurable environment for each APOC user;
- Intuitive and easy to learn;
- Allow APOC stakeholders to observe, study and interact with the data.

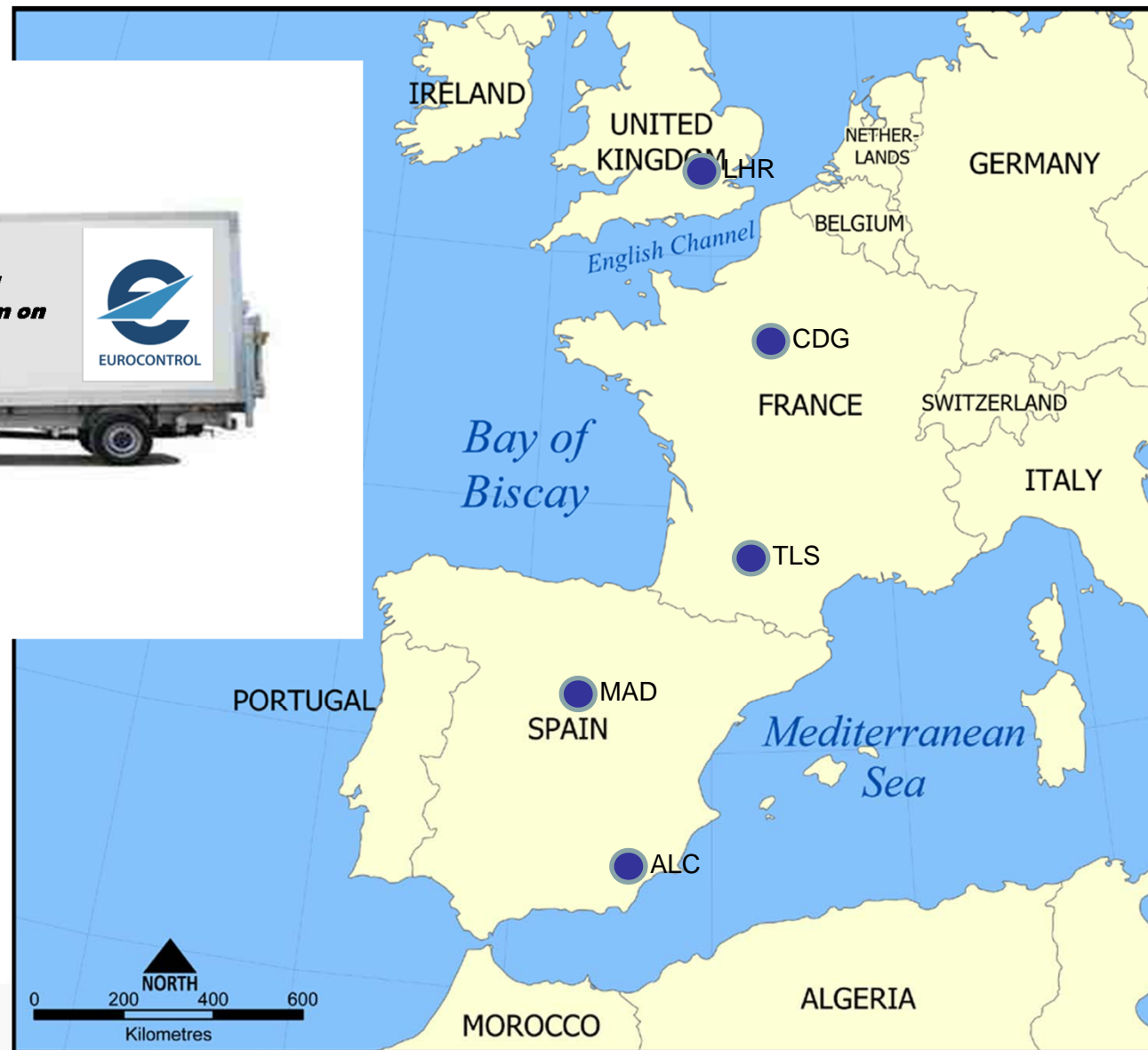# The key : Involvement of operational experts

- Concept 'ownership'
- Simulation Platform provides framework for concept evolution
- Deploy what the end-user wants and obtain management 'buy-in'
- Business Case
- Risk reduction
- Fine tuning and training in preparation for deployment.

www.cast-simulation.com

Remote simulations

Cooperation with Paris-CDG (Airside + T

London Heathrow – September 2016

Airport Operations Manager

Heathrow Traffic Coordinator

Aircraft Flow Manager

Passenger Flow Manager
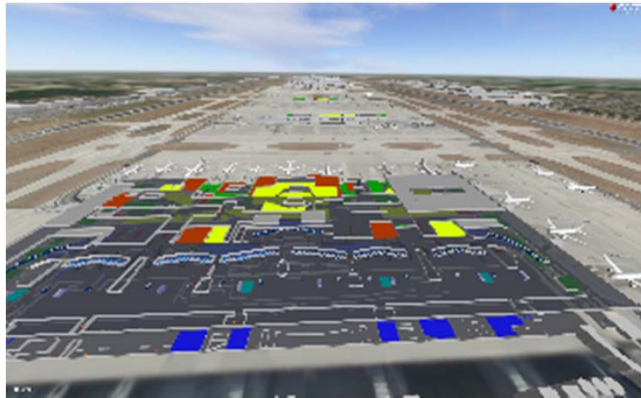
Stand Allocation Unit

Airspace User

Cooperation with Heathrow (Airside + T5)

London Heathrow

An overwhelmingly positive response from all simulation participants to the platform and approach, particularly for a significant enhancement of operational situational awareness

- CAST 3D views
- Dynamic windows environment providing ability to observe operations outside of direct sphere of influence
- All operational data coming from a single source (AOP)
- The ability to instantly understand the downstream impact of one stakeholder's decisions on another
- Strengthened collaborative decision-making

Development of future concepts through simulation

Performance Interactive Dashboard

- Display performance information (historical, actual and forecast);
- Draw attention when alerts are reached;
- Provide tools to dig and find the roots of these problems.

What-if support to decision tool

- Propose options for action to APOC members;
- Evaluate impact of selected options on airport performance in the coming hours.

- Development with our SESAR partners.
- Test different configurations & options to:
  - Identify commonalities across airports;
  - Select the configuration providing the best performance benefits.

APOC Performance Dashboard

Principles

- High level APOC view.

- Structured around airport processes.

- Aggregated & summarized view of more detailed levels.

- Drill down possibility

APOC Overview

Schedule

Processed Traffic
ARR
DEP
0 200 400 600

Cancellations
ARR 0
DEP 0

Arrival Flow
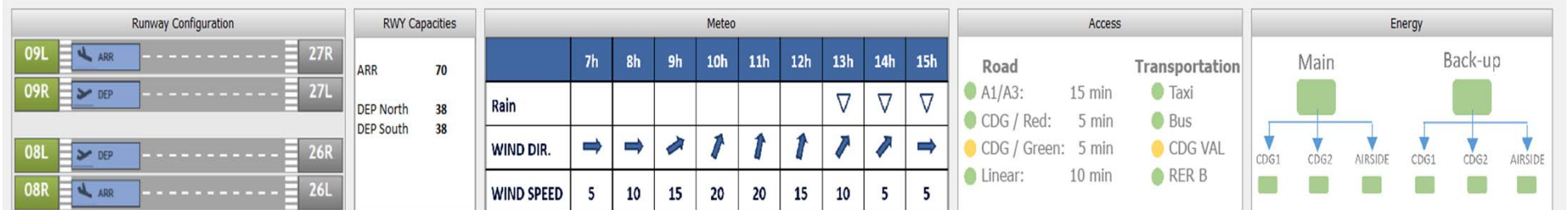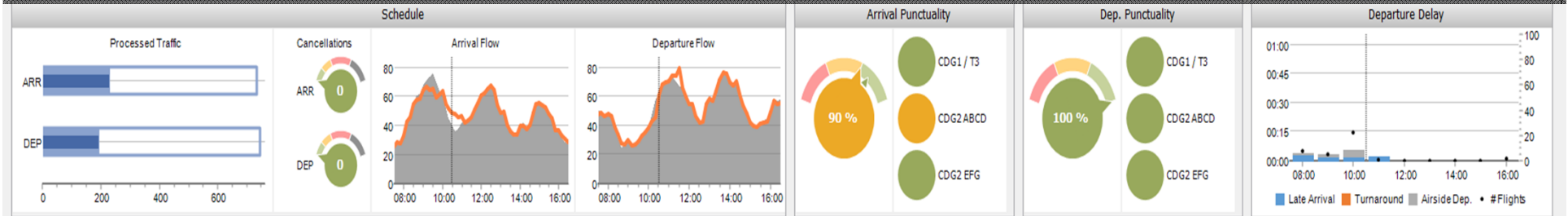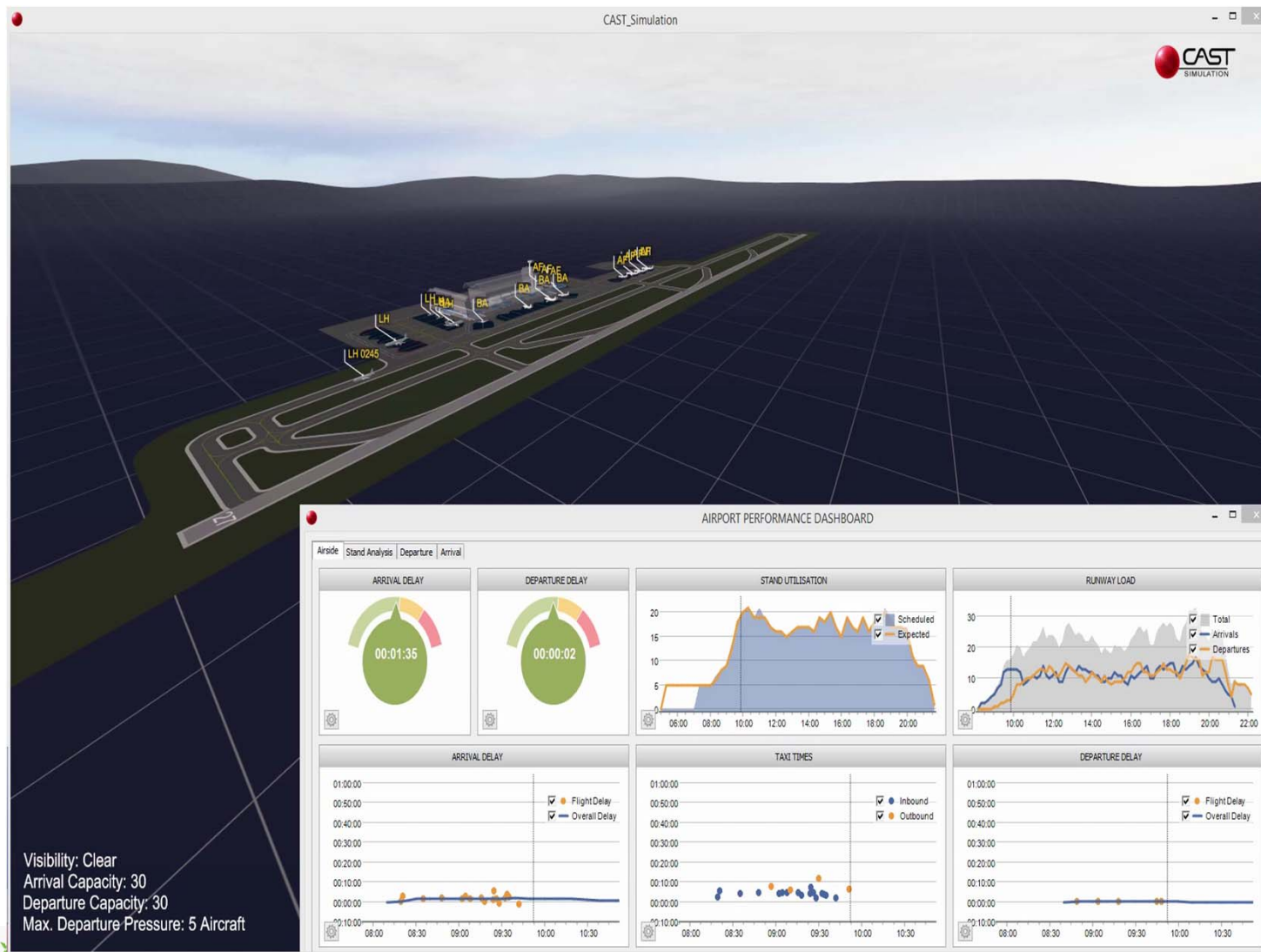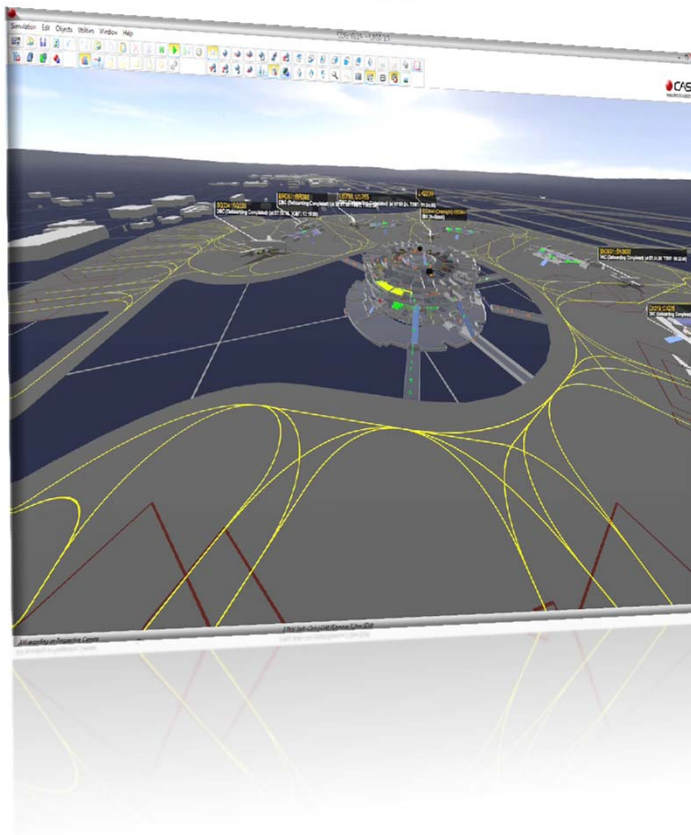80 60 40 20
08:00 10:00 12:00 14:00 16:00

Departure Flow
80 60 40 20
08:00 10:00 12:00 14:00 16:00

Arrival Punctuality
90 %
CDG1 / T3
CDG2 ABCD
CDG2 EFG

Dep. Punctuality
100 %
CDG1 / T3
CDG2 ABCD
CDG2 EFG

Departure Delay
01:00 / 100
00:45 / 80
00:30 / 60
00:15 / 40
00:00 / 20
08:00 10:00 12:00 14:00 16:00
Late Arrival — Turnaround — Airside Dep. · #Flights

Arrival Load

Aircraft		Pax	
12	CDG1 / T3	1529	CDG1 / T3
5	CDG2 ABCD	1219	CDG2 ABCD
10	CDG2 EFG	1673	CDG2 EFG
3	Others	464	Others

Arrival Passengers

	Arr. Border	Baggage	Customs
T1	84 %	69 %	100 %
Non-T1	100 %	100 %	100 %

Taxi Times
ARR 00:09:43
DEP 00:14:22

00:40 00:35 00:30 00:25 00:20 00:15 00:10 00:05 00:00
08:00 09:00 10:00 11:00
Taxi-In · Taxi-Out

Network
Last update : 11/02/2016 16:26
< 15 MIN
< 30 MIN
< 45 MIN
>= 45 MIN
Forecast H
Loop

EDUUFUL1U
EDUUDI
LPPCNXUPP
LICCBZ
LTBA
LTFJ

Departure Load

Aircraft		Pax	
6	CDG1 / T3	722	CDG1 / T3
11	CDG2 ABCD	1791	CDG2 ABCD
25	CDG2 EFG	4231	CDG2 EFG
1	Others	207	Others

Departure Passengers

	Check-In	Dep. Border	Security
T1	100 %	100 %	80 %
Non-T1	100 %	100 %	100 %

Aircraft Stands

Contact Rate 70 %

Stand Availability

	-1h		Current		+1h		+2h
B	3	B	8	B	7	B	3
C	43	C	52	C	64	C	56
D	10	D	10	D	10	D	15
E	10	E	10	E	10	E	27
F	1	F	1	F	1	F	3

Runway Configuration
09L — ARR — 27R
09R — DEP — 27L
08L — DEP — 26R
08R — ARR — 26L

RWY Capacities
ARR 70
DEP North 38
DEP South 38

Meteo

	7h	8h	9h	10h	11h	12h	13h	14h	15h
Rain							▽	▽	▽
WIND DIR.	→	→	↗	↑	↑	↑	↗	↗	→
WIND SPEED	5	10	15	20	20	15	10	5	5

Access

Road
A1/A3: 15 min
CDG / Red: 5 min
CDG / Green: 5 min
Linear: 10 min

Transportation
Taxi
Bus
CDG VAL
RER B

Energy

Main
Back-up

CDG1 CDG2 AIRSIDE CDG1 CDG2 AIRSIDE

Performance Dashboard

APOC What-if support to decision tool

What-if

EUROCONTROL

CAST

"What-if" options:

- What happens if change of runway configuration C in x minutes?
- What happens if closure of taxiway T in x minutes for y minutes?
- What happens if opening of y new security position in x minutes?
- In case of reduction of departure capacity, which flows should be prioritized: arrival/departure: 50/50, 80/20?

Fast time simulations

What-if results

Cooperation with Madrid (Airside + T1/T2/T3 - GA/CARGO)

What-if support to decision tool

Results were computed and displayed in 6 minutes!!

Conclusions from the remote simulations

High "cost" in terms of realisation

Participant availability can be an issue - lack of flexibility

But…

- Great opportunity to demonstrate to operational staff the work coming out of SESAR
- Opportunity for senior management to visit
- De-risk prior to investment
- High potential for training
- Excellent vehicle for demonstrating feasibility of future developments :
  - Total airport view
  - Performance monitoring and management
  - 'what-if' capability through simulation

UEFA Euro 2016 Football Championship

- Held in France from 10 June to 10 July 2016.
- 10 host cities:
  - Bordeaux, Lens, Lille Métropole, Décines-Charpieu, Marseille, Nice, Paris, Saint-Denis, Saint-Étienne, and Toulouse
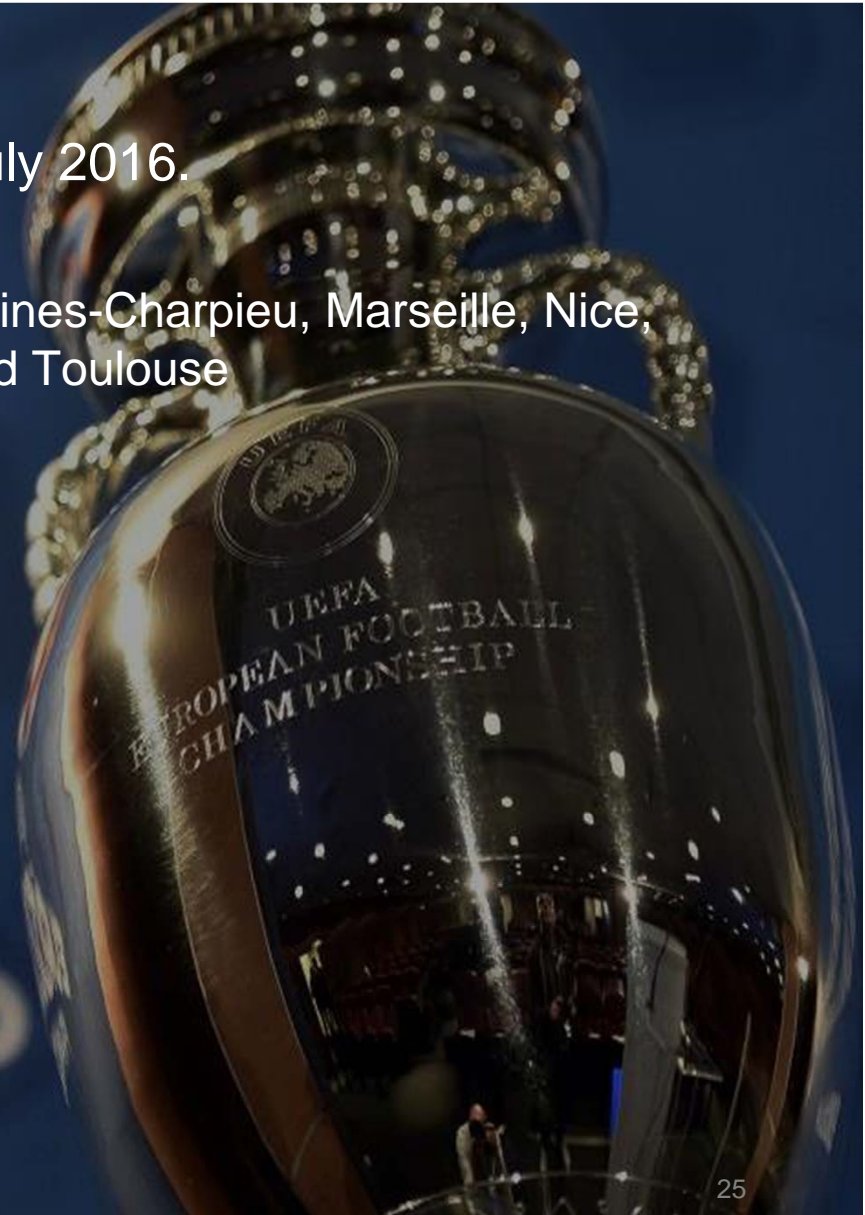
Matches in Bordeaux

Date	Time	Team 1	Result	Team 2	Attendance
11 June 2016	18:00	Wales	2 – 1	Slovakia	37 831
14 June 2016	18:00	Austria	0 – 2	Hungary	34 424
18 June 2016	15:00	Belgium	3 – 0	Ireland	39 493
21 June 2016	21:00	Croatia	2 – 1	Spain	37 245
2 July 2016	21:00	Germany	1 – 1 (6-5p)	Italy	38 764

Terminals in Bordeaux

- The airport has three terminals:

Terminal modelling – Departure level

- Check in counters.
- Security positions.
- Border control.
- Boarding rooms.

Detailed simulation model

Queueing time at Security Con

Bathroom

Measurement campaign – Preparation

Figure 1: Departure Passenger per rolling hour

21.12.2015 - Passengers per rolling hour, Schengen Status and Terminal

Time Interval 1
Time Interval 2
Time Interval 5

— Hall_A Dep — Hall_B Dep — Billi Dep

Figure 2: Non Schengen Passenger per rolling hour

21.12.2015 - Passengers per rolling hour, Schengen Status and Terminal

Time Interval 3
Time Interval 4
Time Interval 6

— HallA_NonSchengen_Arr — HallA_NonSchengen_Dep — Billi_NonSchengen_Arr

Scenarios & Simulations

- **Objective:** show a range of possible situations different scenarios to prepare BOD for the worst case.

- The main factors that described the different scenario were:
    - Number and scheduled time of EURO fan flights;
    - Bus schedule of fans arriving at the airport after the end of the match;
    - Requirement of extraordinary border control during the tournament.

→ Scenarios discussed with BOD and taking account of the latest available information.

Additional immigration control in Hall A

Simulation Results 11 June 2016
Wales – Slovakia

- **Security demand:**

Security: Demand (15 min)
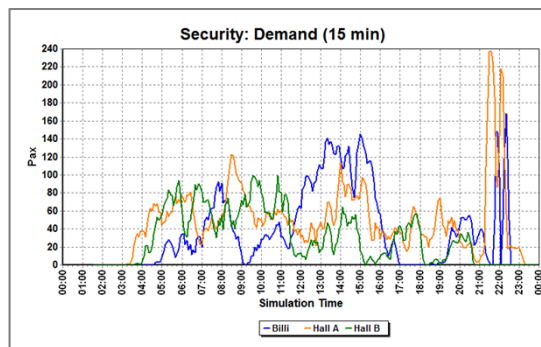
Facility		# Facilities	Capacity [PAX/ h]	Capacity [PAX/ 15 min]
Security	Hall A	4 lanes	568	142
	Hall B	4 lanes	436	109
	Billi	4 lanes	480	120
Emigration	Hall A	3 Counters	720	180
	Hall A (add.)	2 Counters	480	120
	Pier	2 Counters	480	120
	Billi	3 Counters	720	180
Immigration	Hall A	4 Counters	720	180
	Pier	2 Counters	360	90
	Billi	3 Counters	540	135

- **Bus schedule:**

Legend	
	Bus Arrival
	STD
	Min arrival of last flight
	Match End
	First Bus at Terminal

  - **Worst case:**
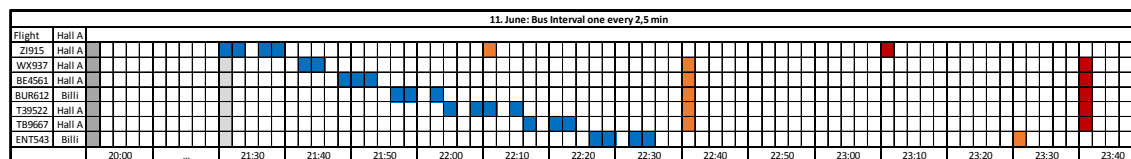
  - **Optimal scenario:**
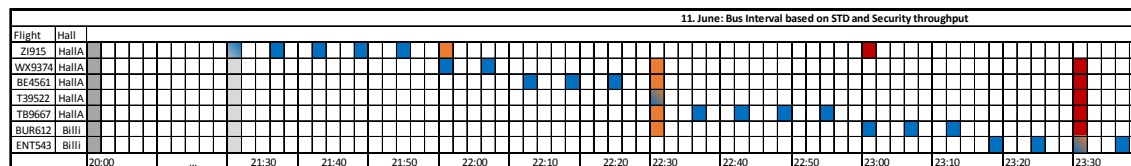
Wales – Slovakia
Conclusions

- The simulation does not show any significant problems or bottlenecks:

  - Expected demand and number of passengers can easily be handled;

  - Waiting times and queue are acceptable;

  - Almost no queues or waiting times at emigration.

- The bus schedule is the main trigger of the demand at security after the match:

  - Influences significantly the resulting waiting times and queues (worst case: 20 min, can be optimized with optimized bus sequence).

- Additional controls can be considered to reduce the waiting times during the arrival peak.

Conclusions of the project

EUROCONTROL

- The simulation and especially the videos helped BOD:
  - All matches were discussed in detailed with BOD:
    - Simulation results were evaluated and interpreted;
    - Videos of the critical situations were shown;
    - Possible mitigations were presented, explained and developed.
- It was the first time BOD was confronted with an ultra-realistic terminal simulation and showed them the benefits of simulation.
- It helped BOD to focus on the main issues and showed that even in the worst case the terminal capacity is enough to handle all passengers.
- It showed that waiting times and queues will occur but that they are manageable and can be reduced with some operational measures.

- The simulations showed that the videos that were too conservative with regards to the stair accesses;
  - Restructuring EUROairports dalwaistottimesgare queues.
  - This resulted in even shorter queues and waiting times than expected based on the simulation results.
  - Because of the increased security capacity BOD decided to let the busses arrive as soon as they can. They knew from the simulation that the gate area would be sufficient.

to Restructuring EURO factors for a waiting message and the throughput capacity at the securities could be increased from 100-180 passengers per hour to almost 220 passengers per hour.

6 Staffed Immigration Controls - different location of mobile counters

33

Predictable   Efficient   Resilient

To transform customer service, we need to improve punctuality.

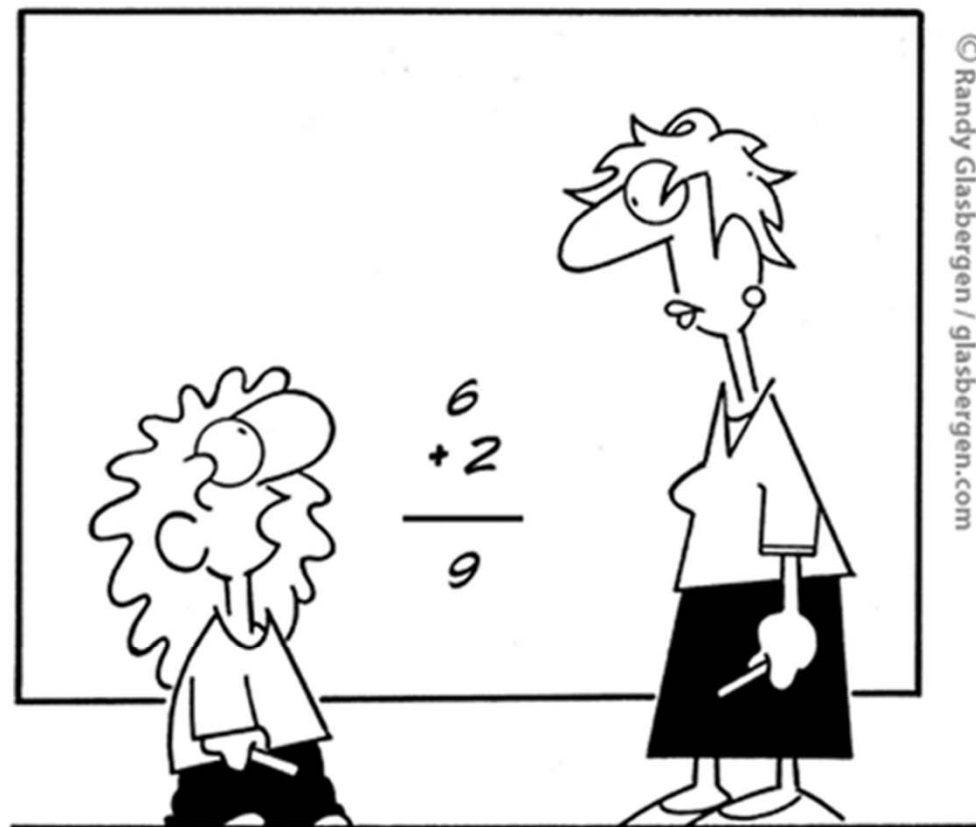Departure punctuality is an important aspect of passenger experience.

APOC

Our mission :

"To reach new heights in airport operations validation activities"

Thank You