

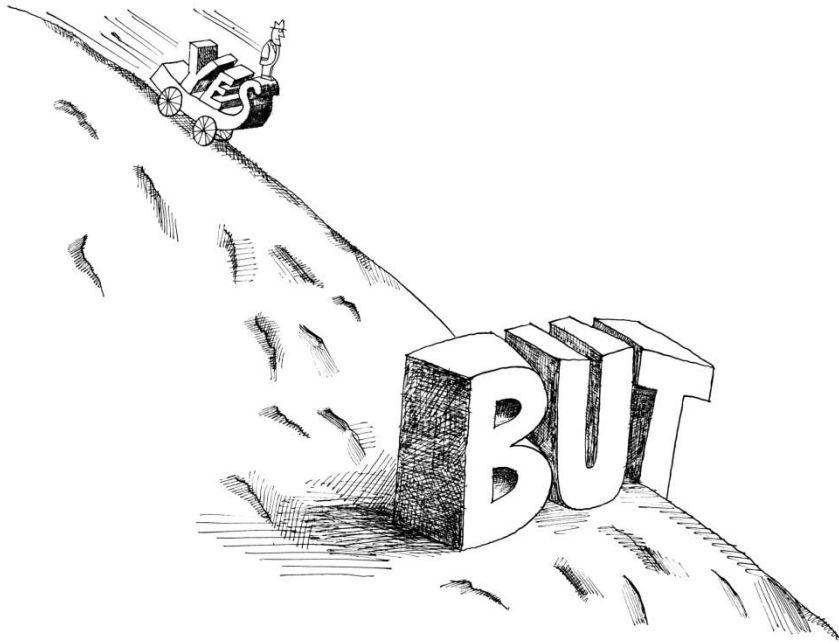


Is there a role for the human controller in future ATM?

Marc Baumgartner
SESAR / EASA Coordinator

27.11.2015 Predicting Fatal Flaw
Royal Aeronautical Society



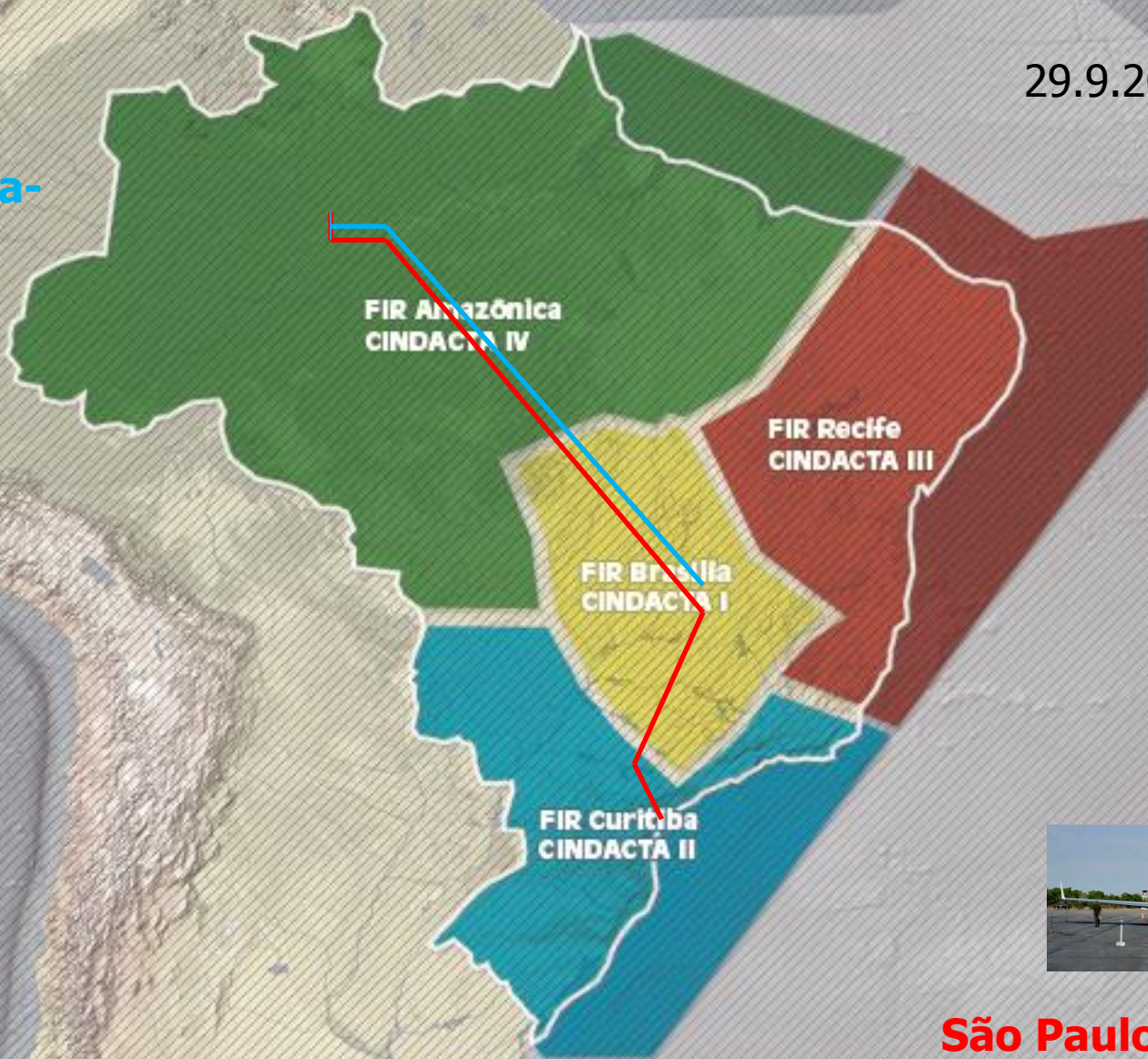


Divisão por Região de Informação de Voo (FIR)

29.9.2006



**Manaus- Brasília-
Rio de Janeiro**



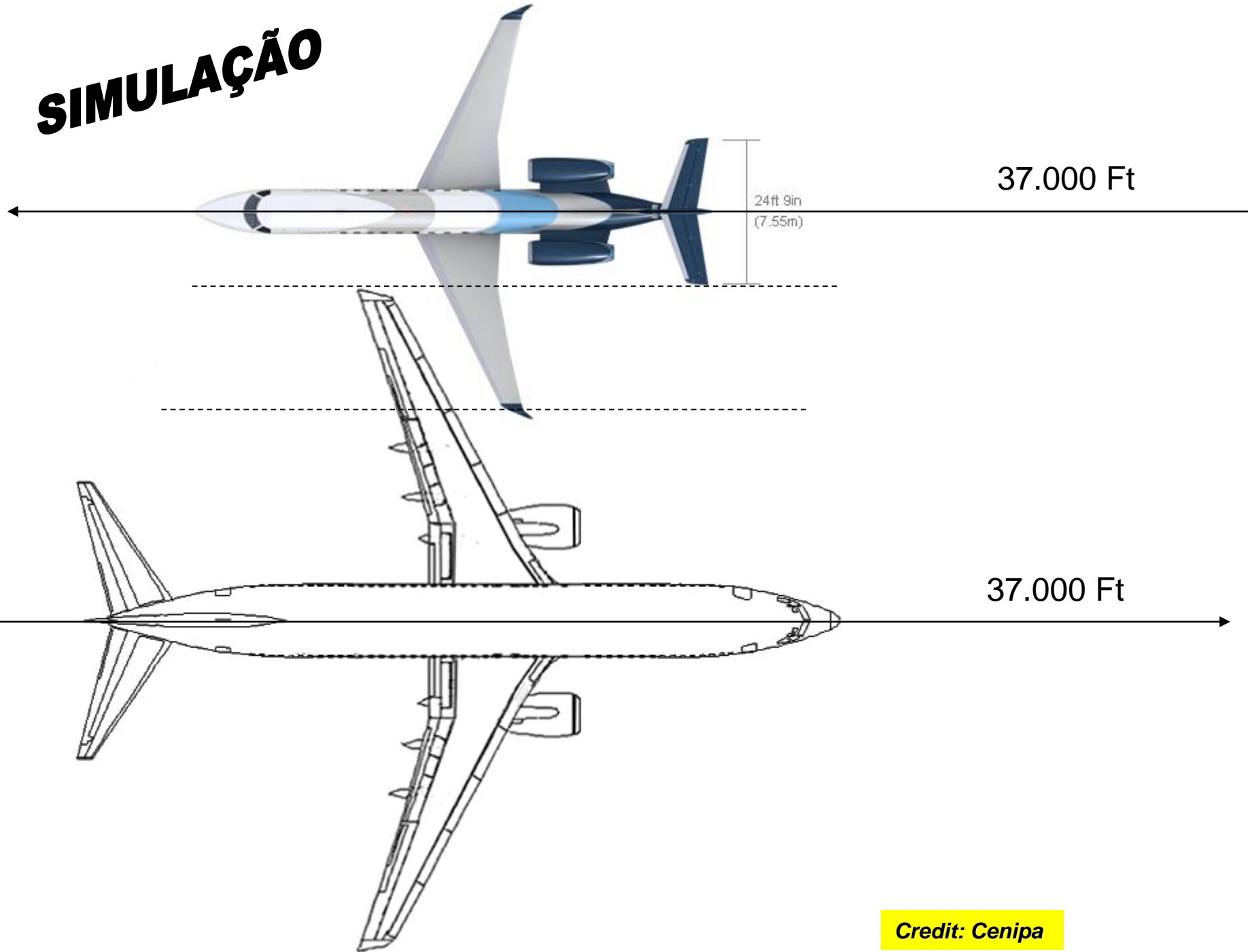
**FIR Atlântico
CINDACTA III**



**São Paulo State -
Manaus- Ft. Lauderdale**

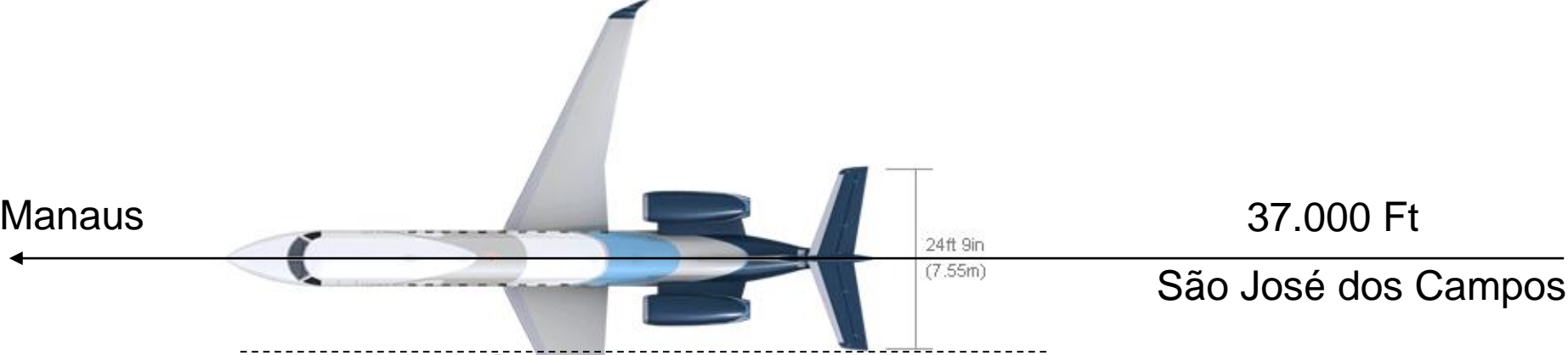
Note to scale
source author
Credit internet

SIMULAÇÃO



Credit: Cenipa

Manaus

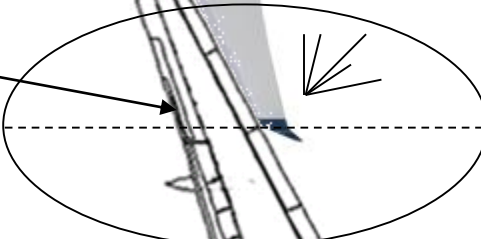


37.000 Ft

São José dos Campos

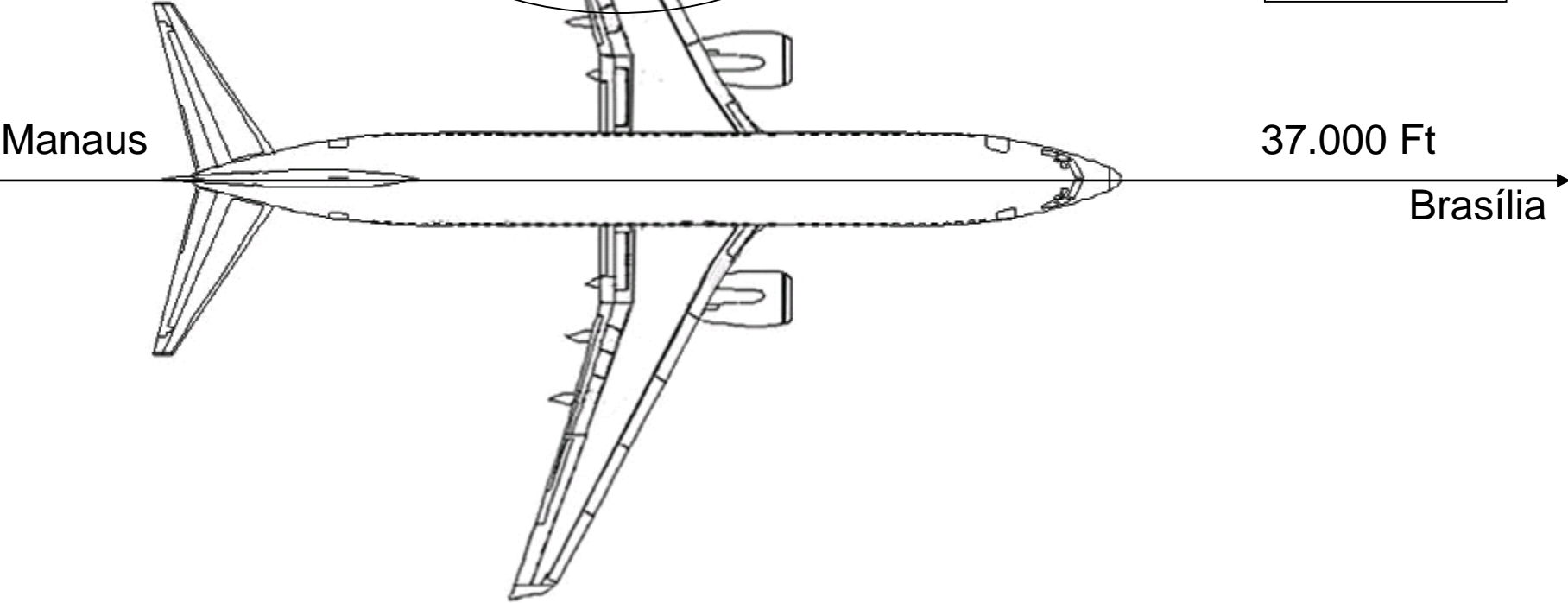
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(7.55m)

Aileron



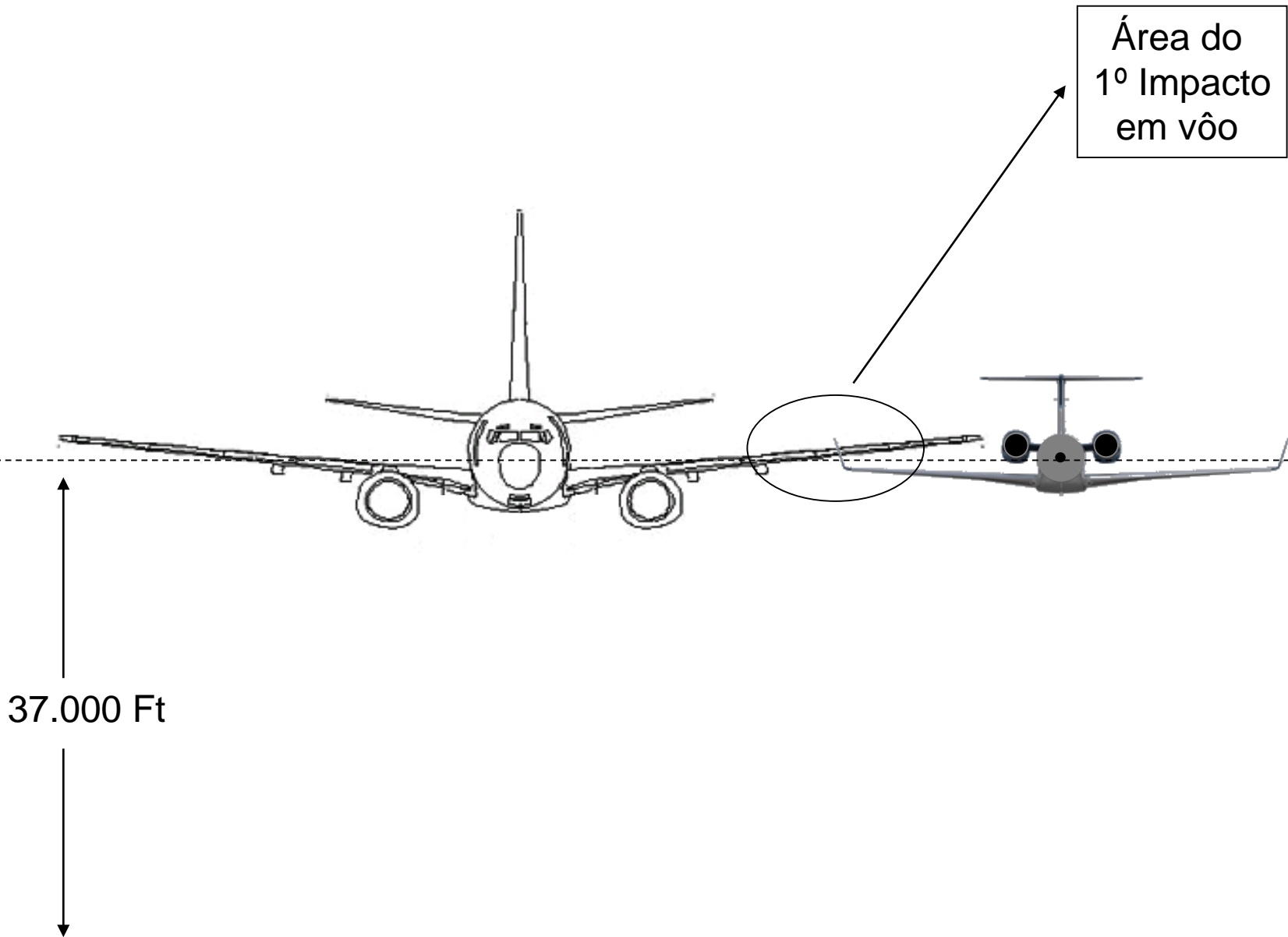
Área do
1º impacto
em vôo

Manaus

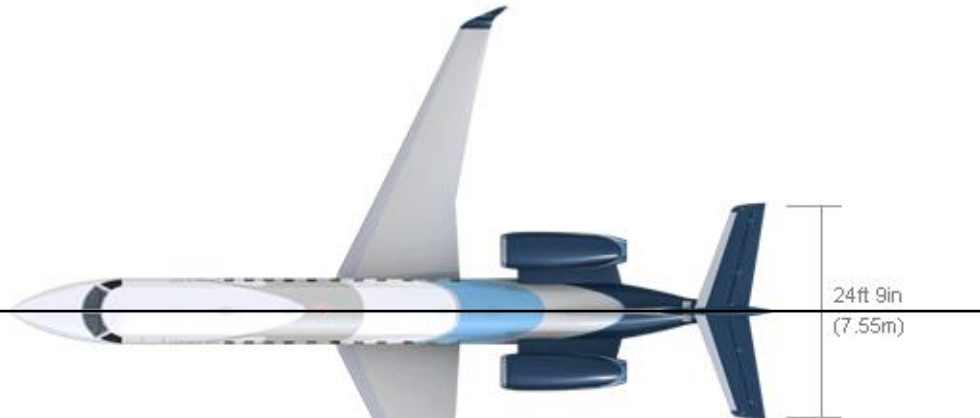


37.000 Ft

Brasília



Manaus

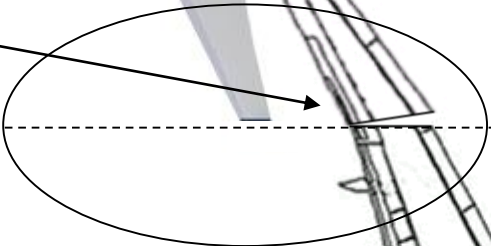


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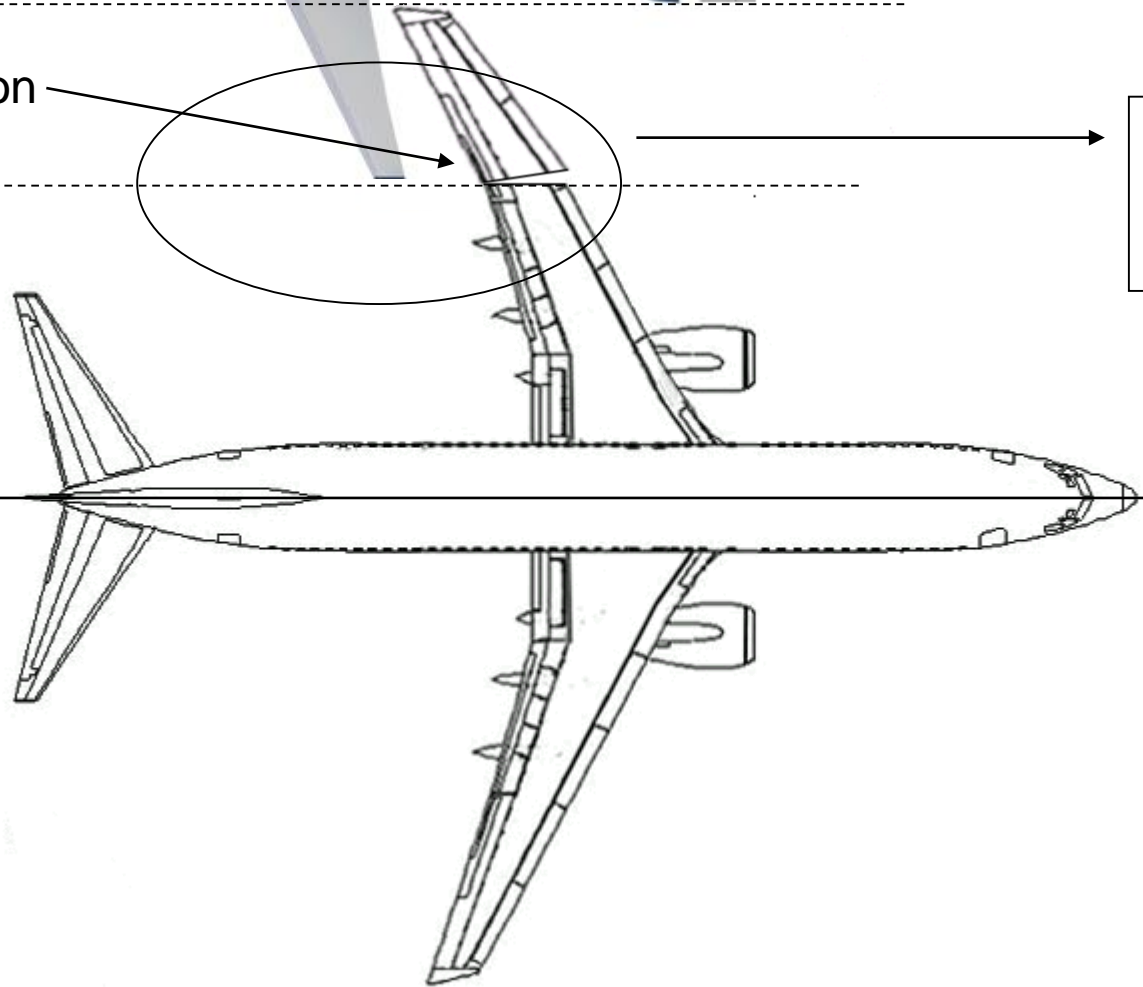
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(7.55m)

Aileron



Área do
1º impacto
em voo

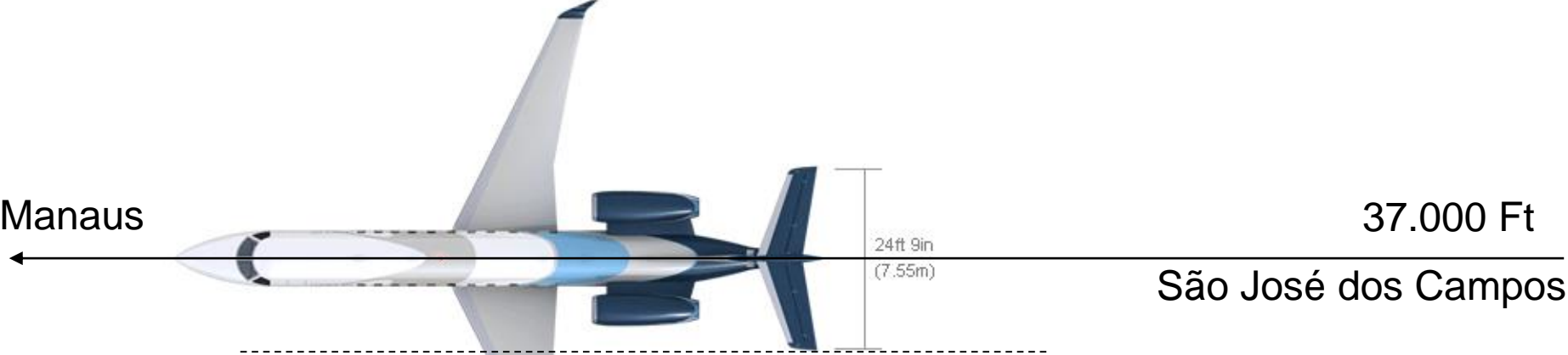
Manaus



37.000 Ft

Brasília

Manaus

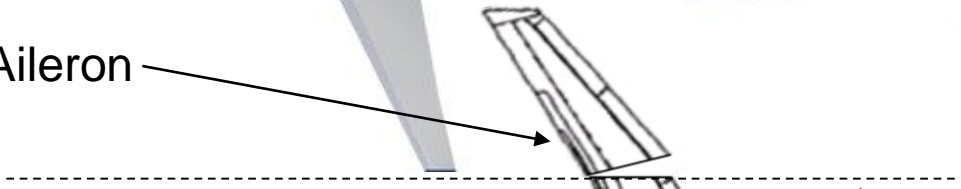


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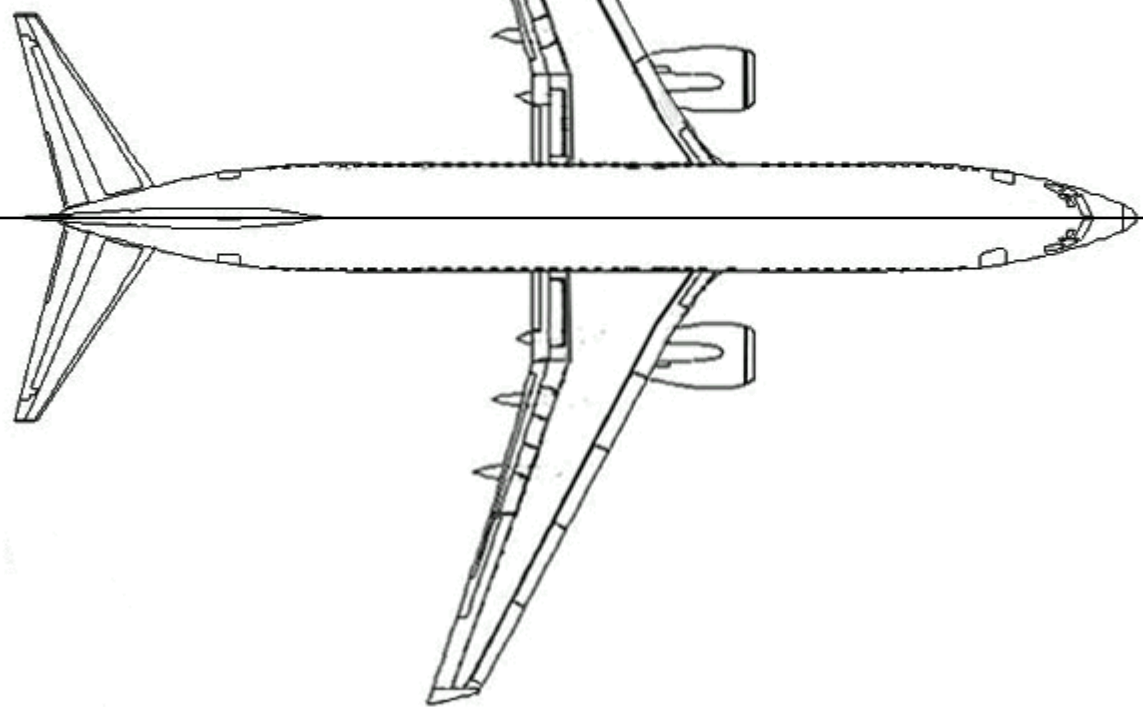
São José dos Campos

24 ft 9in
(7.55m)

Aileron

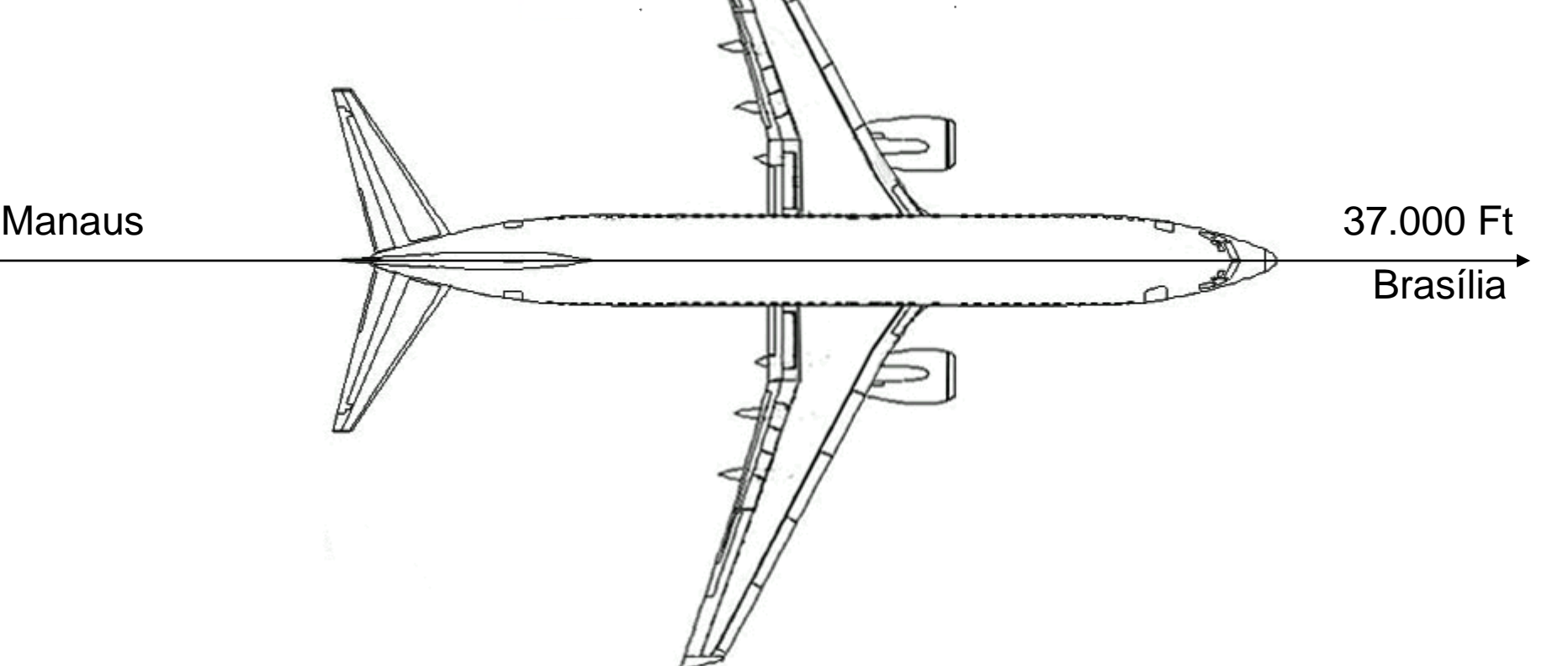
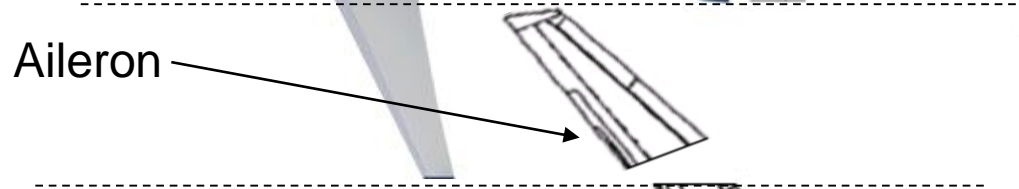
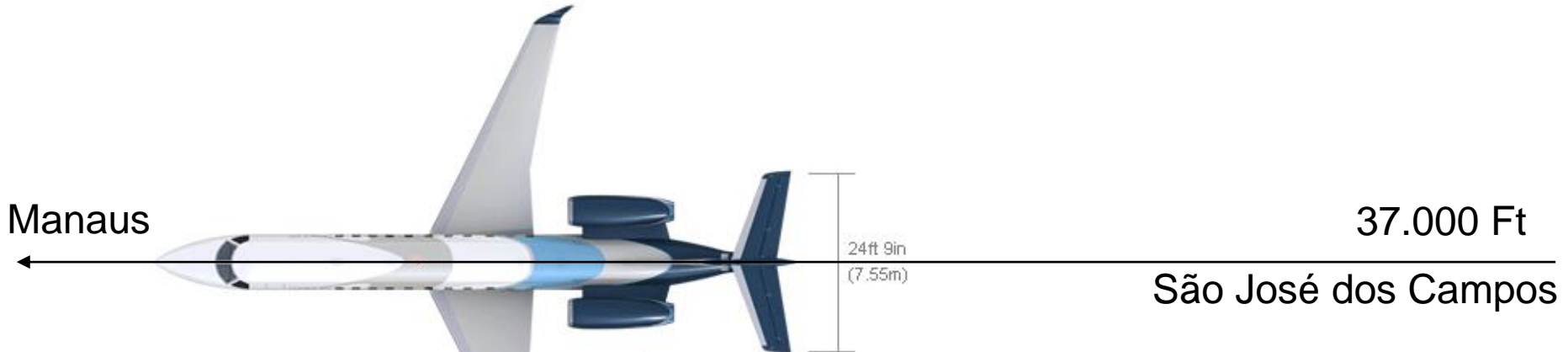


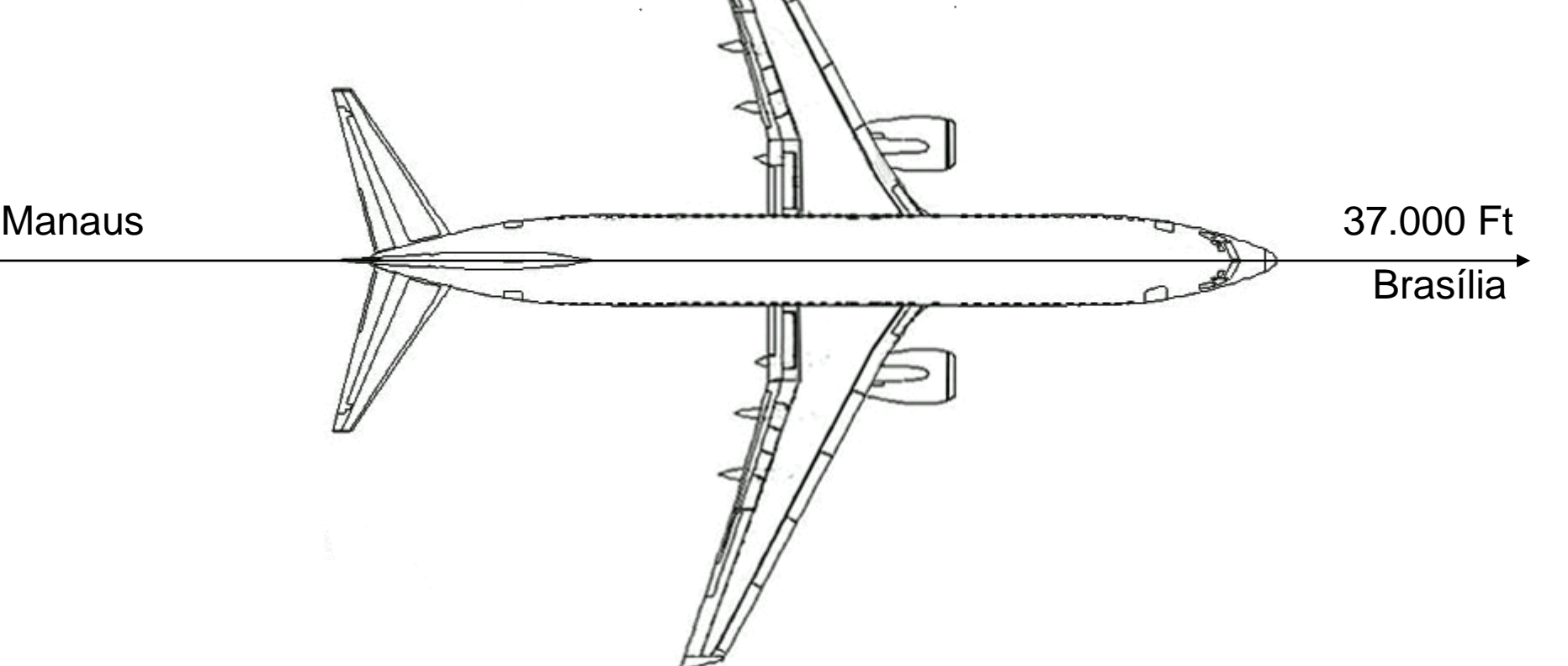
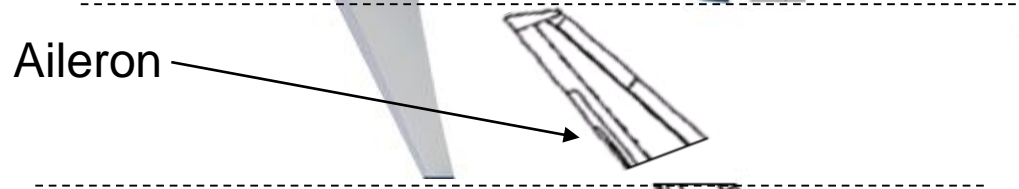
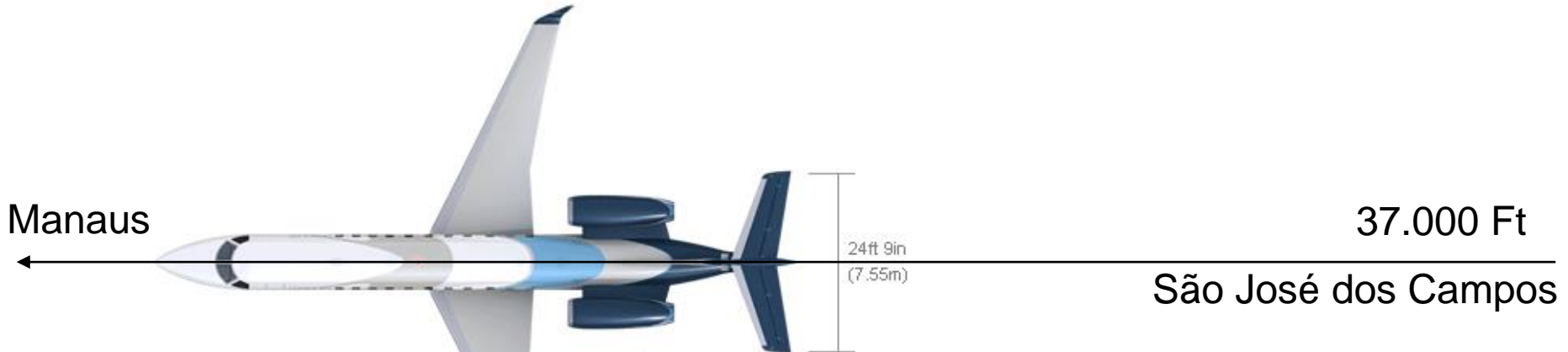
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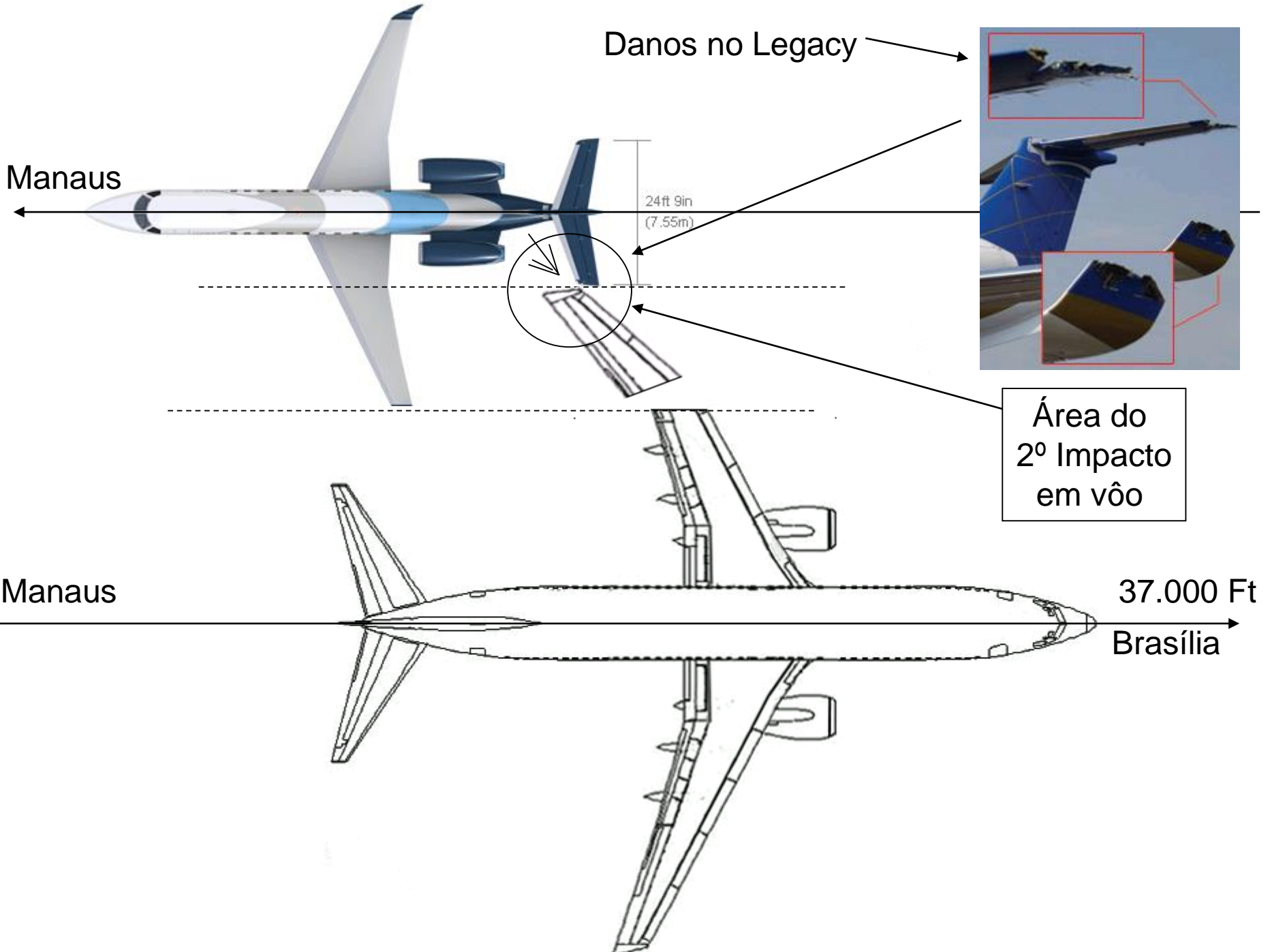


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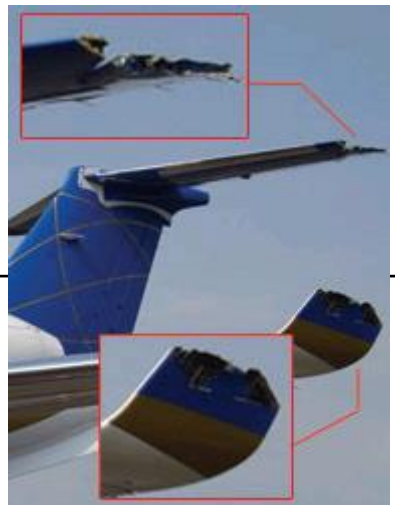




Danos no Legacy

Manaus

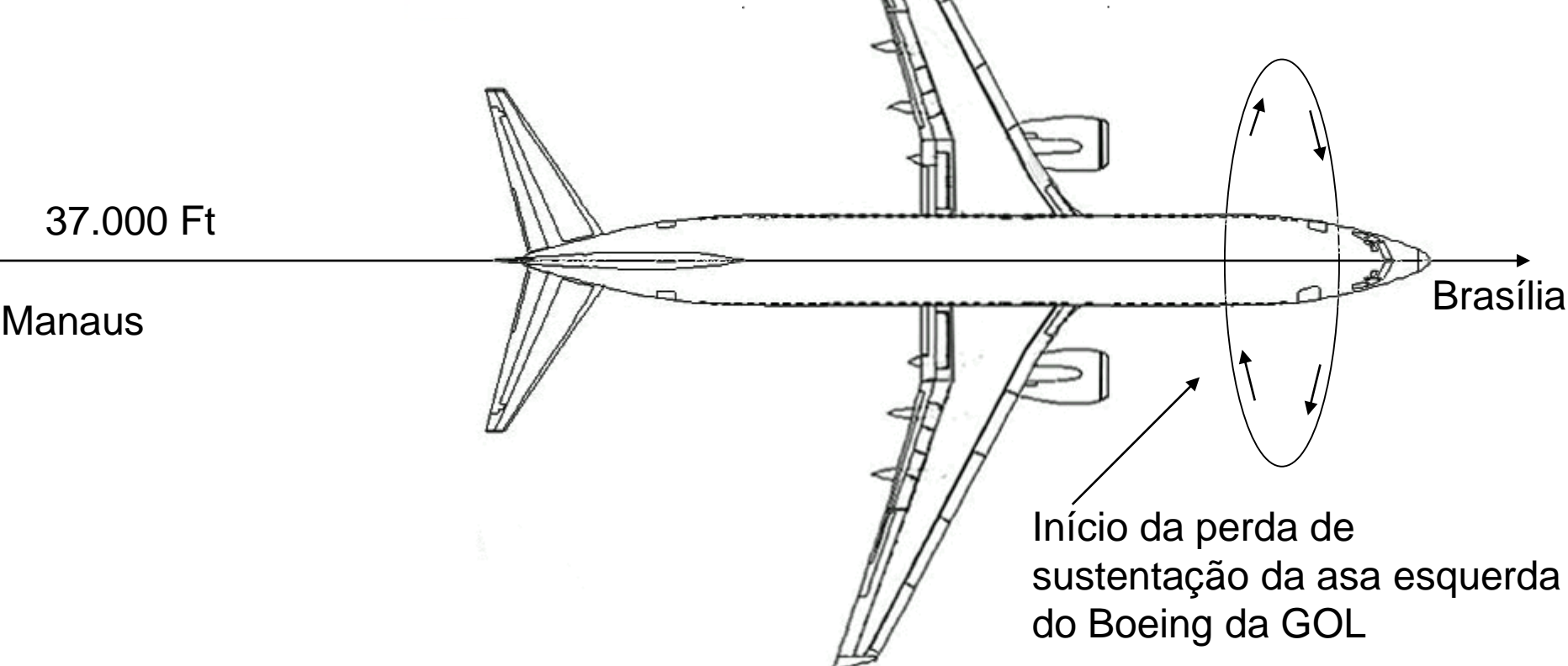
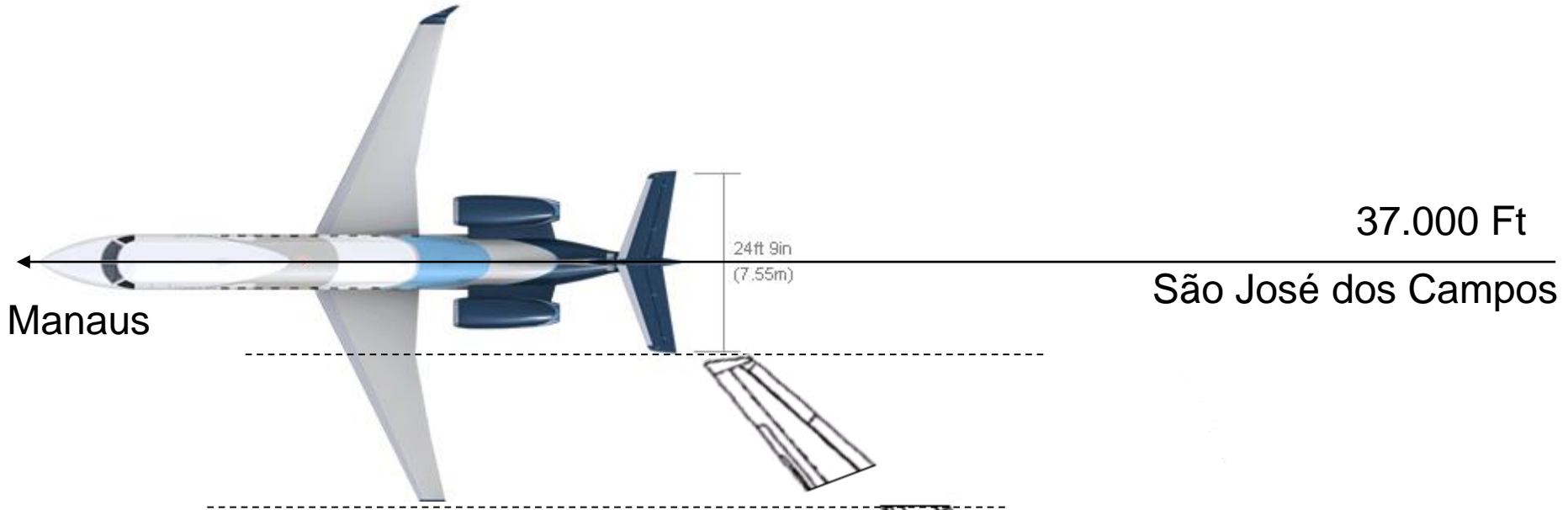
24ft 9in
(7.55m)



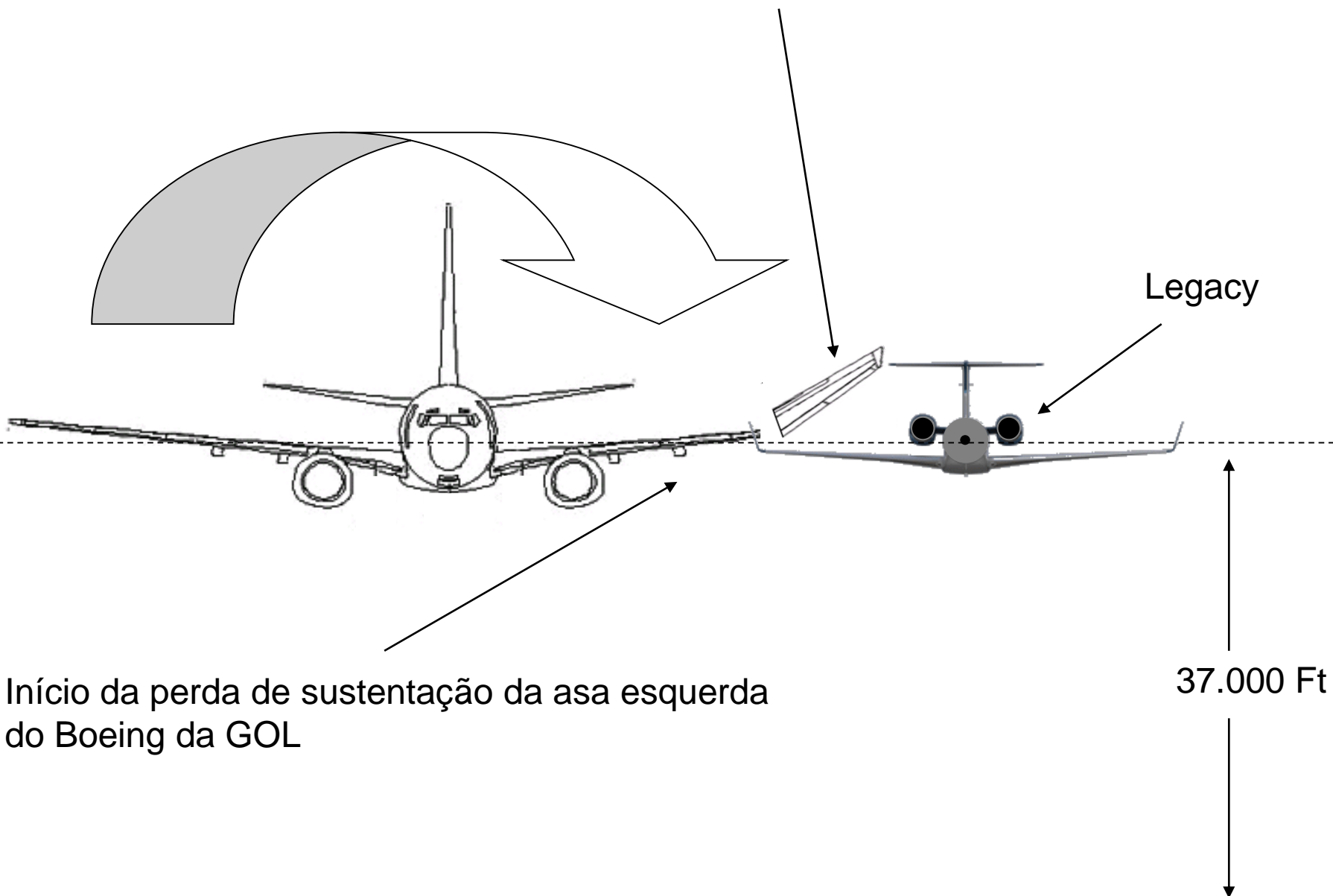
Área do
2º Impacto
em vôo

Manaus

37.000 Ft
Brasília



Perda da ponta da asa do Boeing da GOL

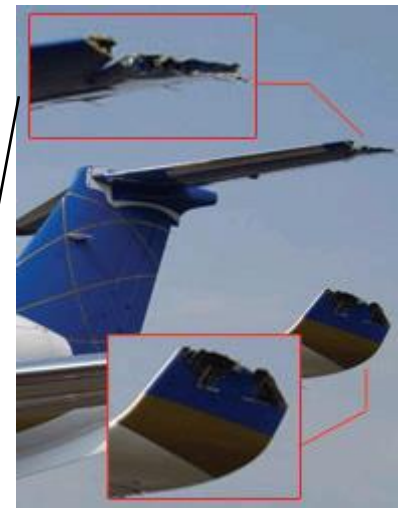


Início da perda de sustentação da asa esquerda do Boeing da GOL

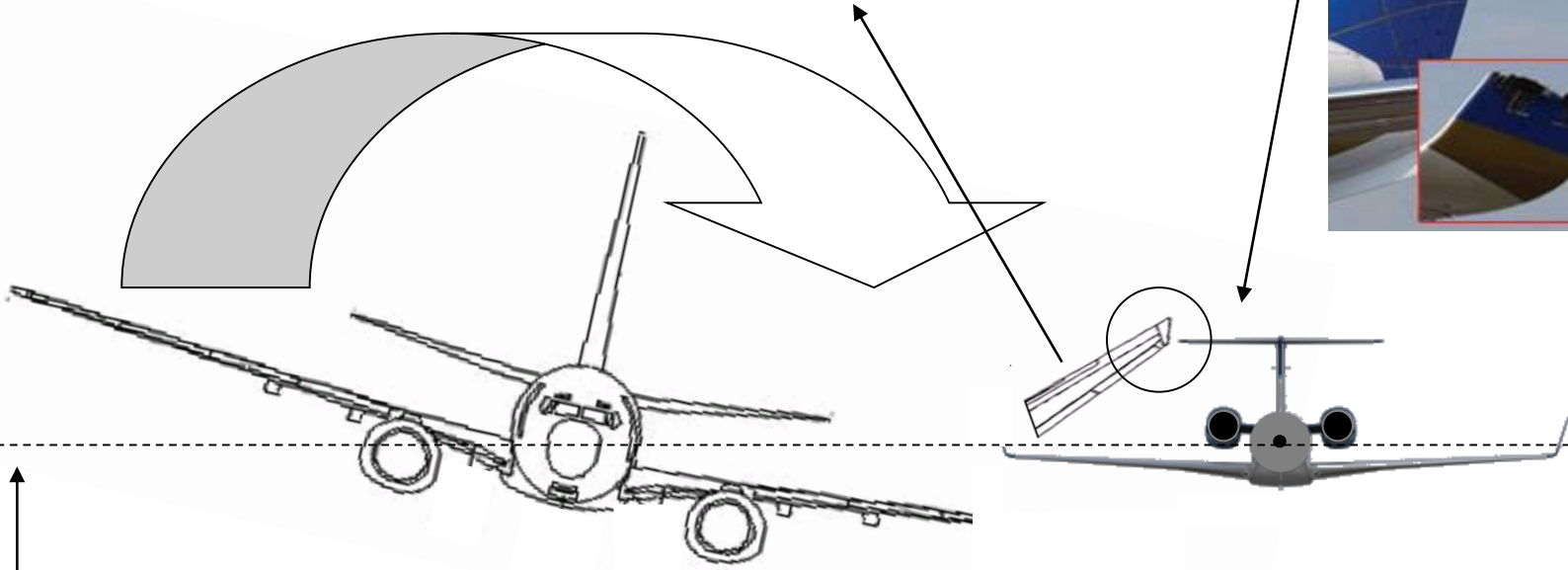
Legacy

37.000 Ft

Danos no Legacy



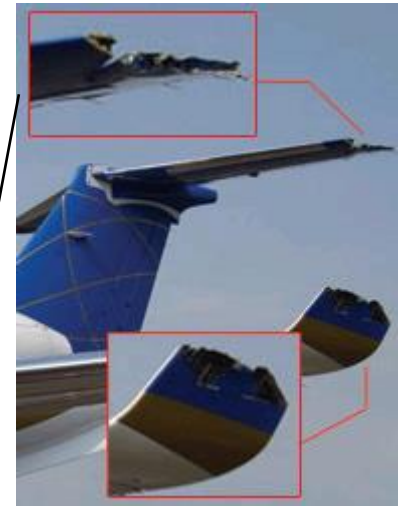
Ponta de Asa do Boeing



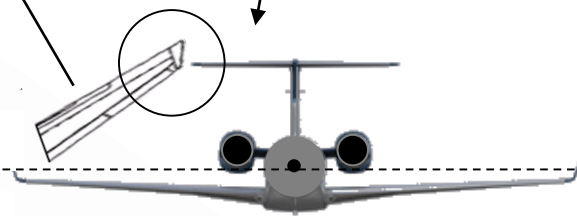
37.000 Ft

Perda da ponta da asa do Boeing da GOL

Danos no Legacy



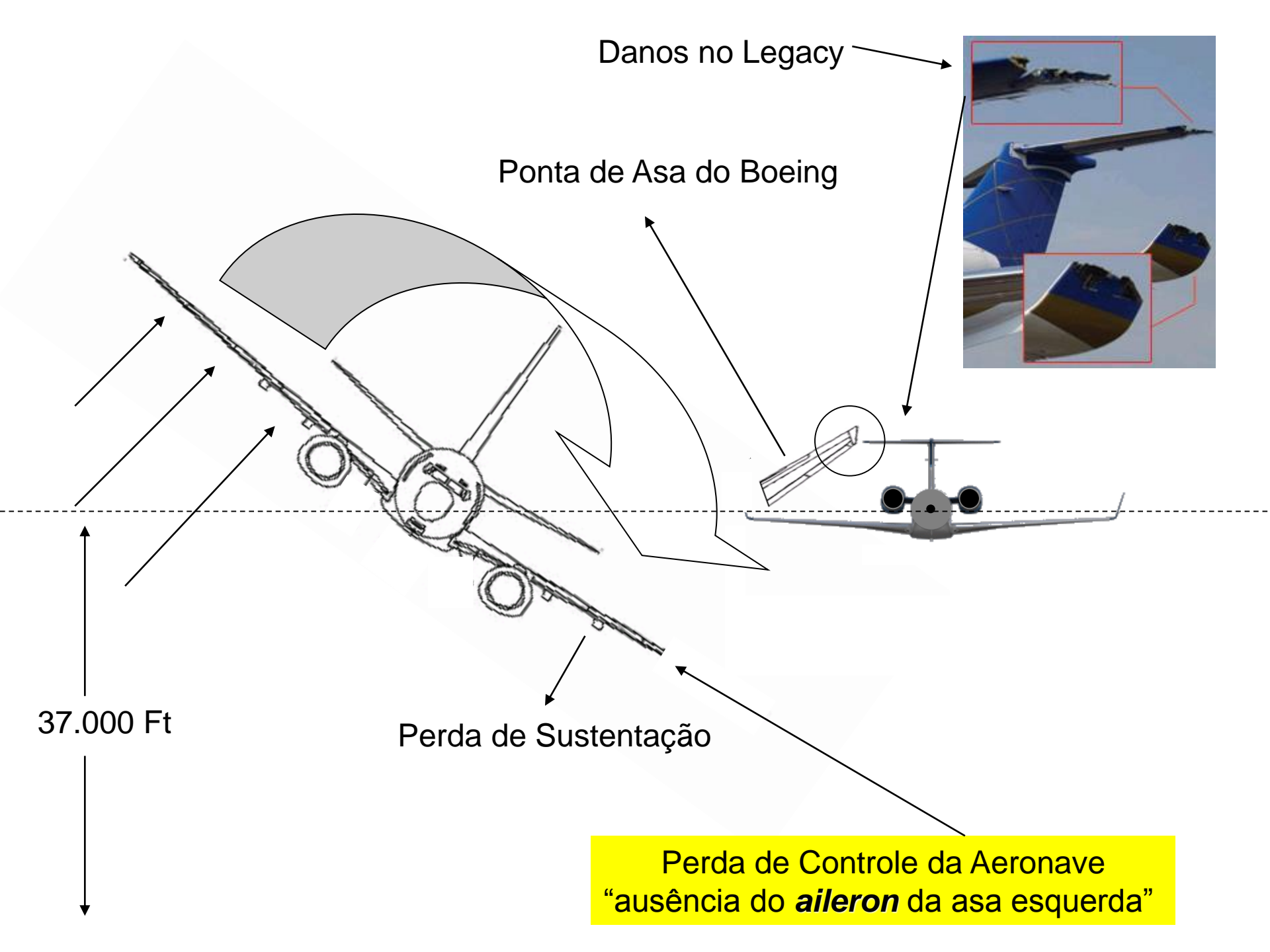
Ponta de Asa do Boeing



37.000 Ft

Perda de Sustentação

Perda de Controle da Aeronave
"ausência do ***aileron*** da asa esquerda"





Militares
da FAB

AERONAVE DO ACIDENTE – APÓS O ACIDENTE

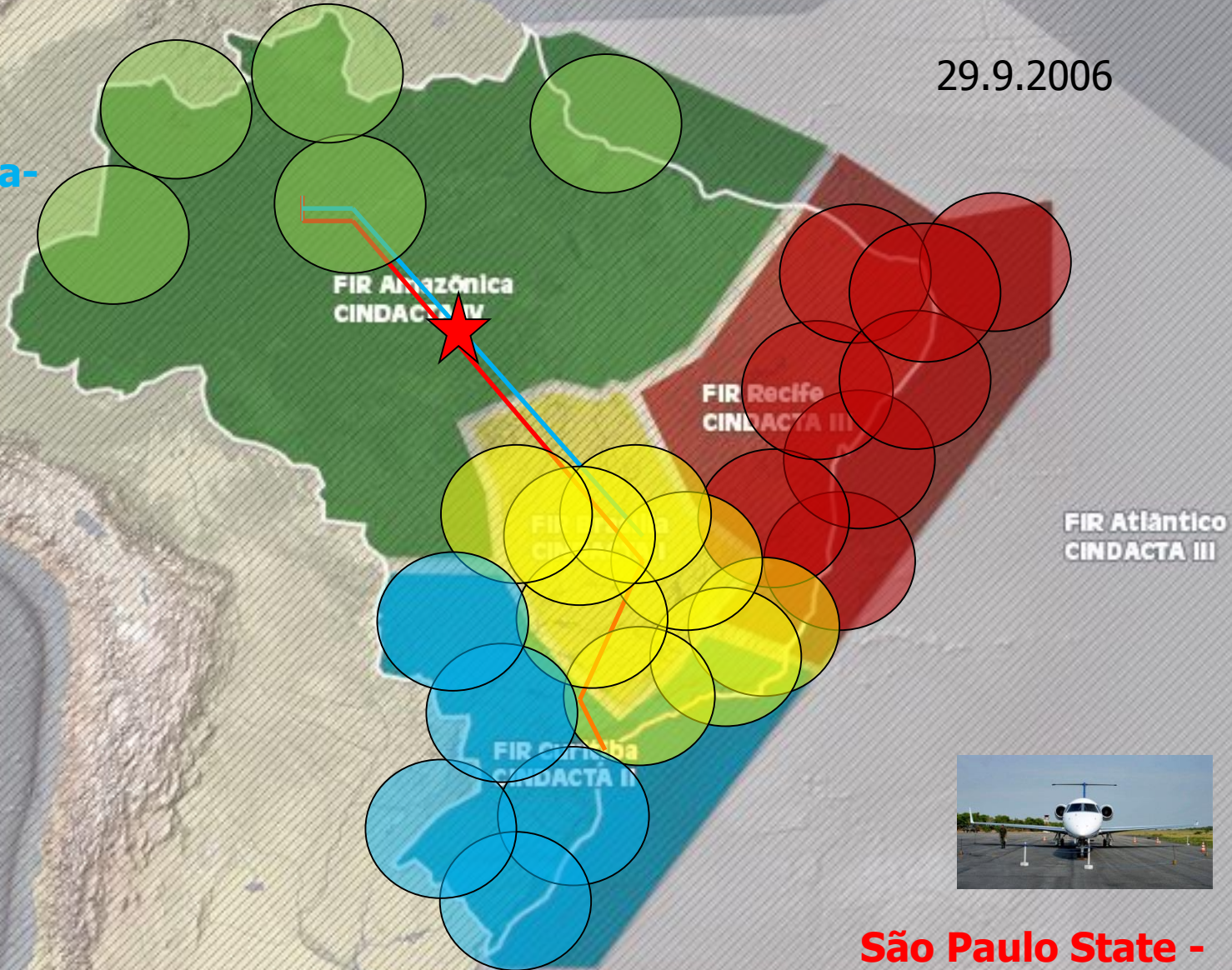


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29.9.2006



**Manaus- Brasília-
Rio de Janeiro**



**São Paulo State -
Manaus- Ft. Lauderdale**

Note to scale
source author
Credit internet

TRANSPONDER INFORMATION LOSS

N600XL
370Z360
46 S077W

GLO1693
0627400
25 S097W

PRR13G
140-160
26 7X

155
30
4.0

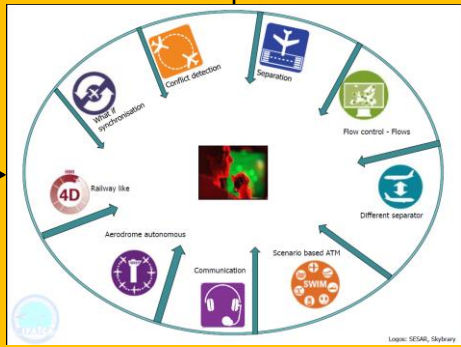
19:02:08 UTC

3d Radar



Credit: IFATCA – the controller

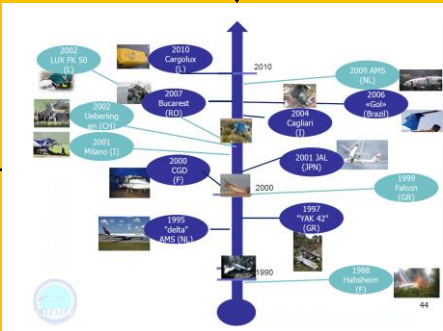
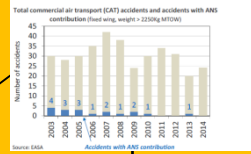




Assesment from an ATCO Point of view



Civil Aviation's Evolution of Safety (ICAO) SESAR. Includes text about flight systems (1970s-1980s), safe systems (1970s - mid-1980s), and ultra-safe systems (mid-1990s onwards).



Toward a strategic view on safety. Includes a diagram with 'PROBLEM/CHALLENGE' and 'JUST CULTURE'.



How does the current system work ?



Credit avshop



Credit: airtrafficmanagement

Today ATM process « innovations »

- US NAS in Jovial still in operation , ERAM ?
- MADAP in IBM assembleur still in operation, ITEC ?
- UK FDP in Jovial still in operation, ITEC?
- CAUTRA IV in LTR,COFLIGHT?
- SATCA in ADA, ITEC?
- VAFORIT?



Credit avshop



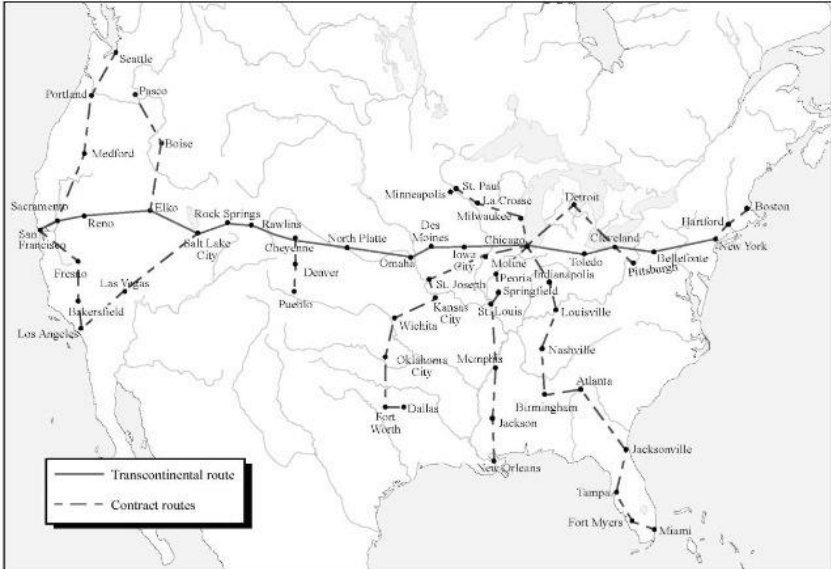
Credit Baumgartner



Credit: www.si.edu



<http://lin-ear-th-inking.blogspot.ch>



© AIRBUS S.A.S. 2014 - photo by master films / A. TCHAKOVSKI



Communication



ATM
Separate,
Expeditious,
Orderly



Navigation



Surveillance

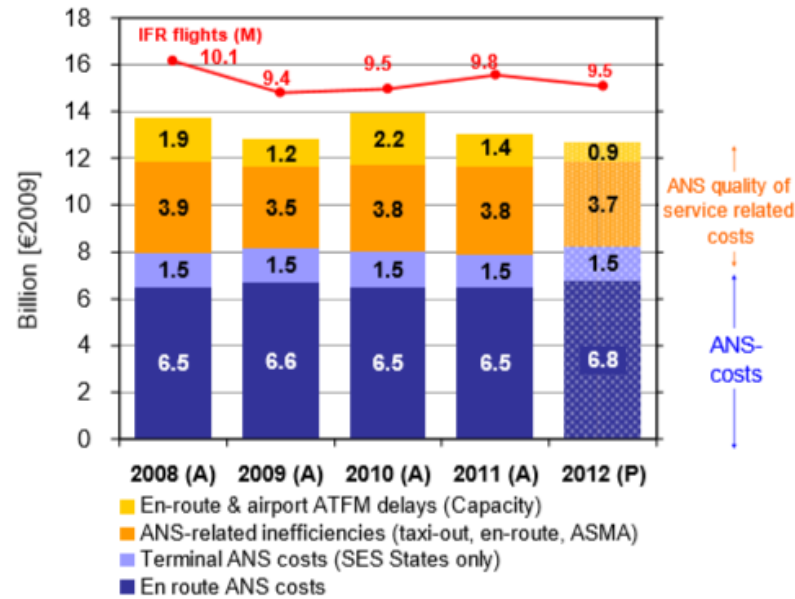


CNS/ATM

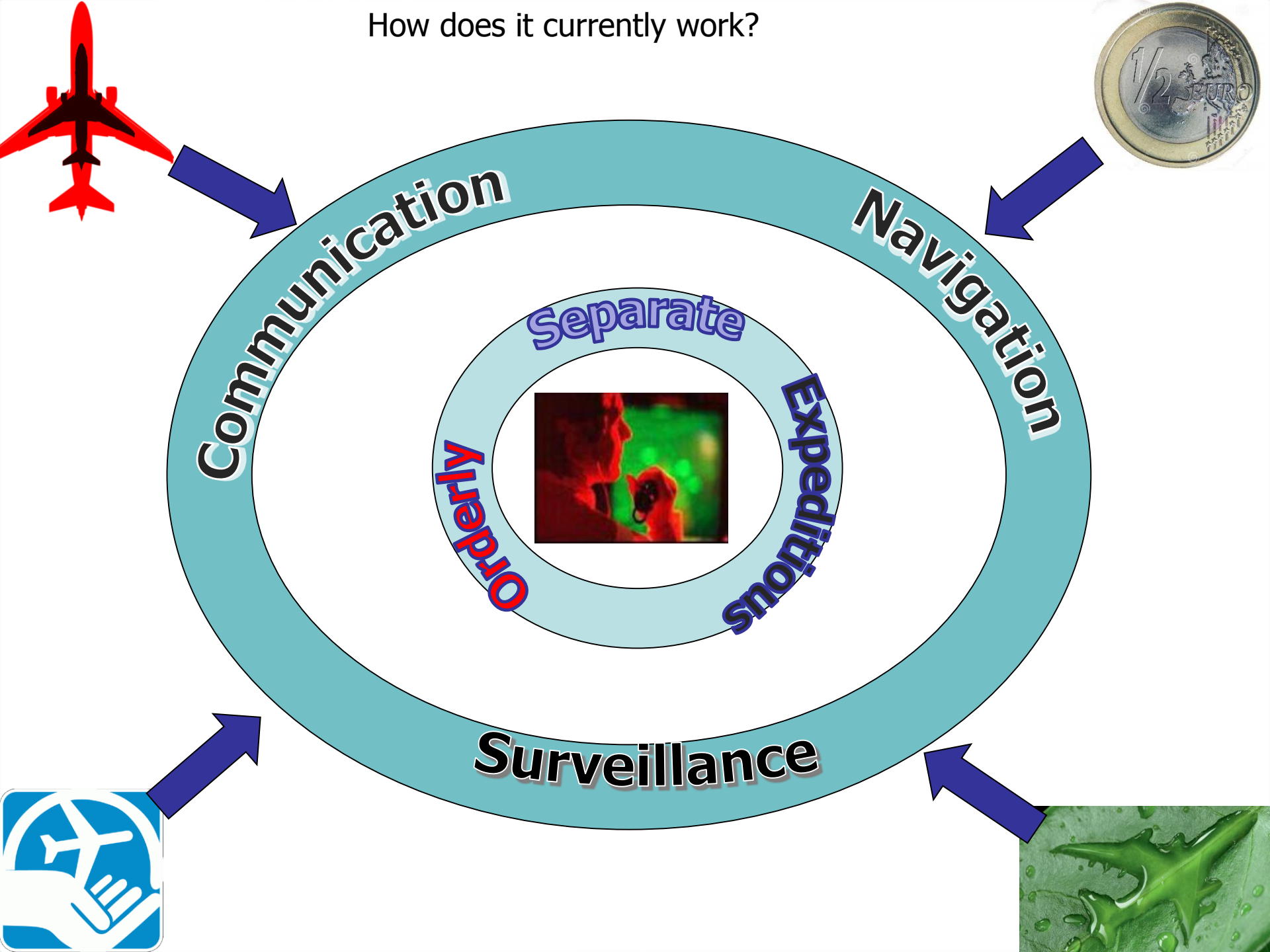
Pressures on the system - Single European Sky context



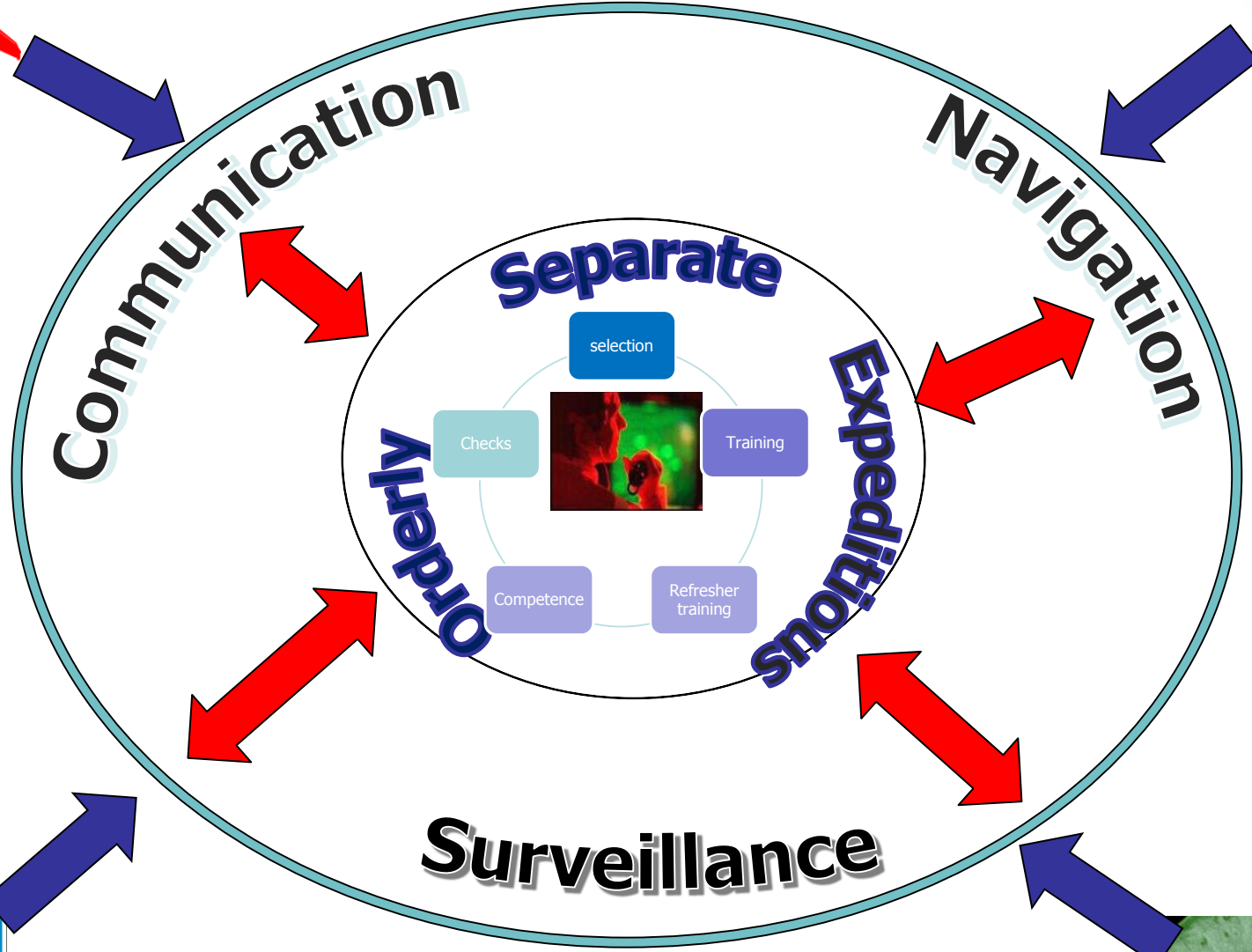
Estimated ANS-related economic costs to airspace users (gate-to-gate)



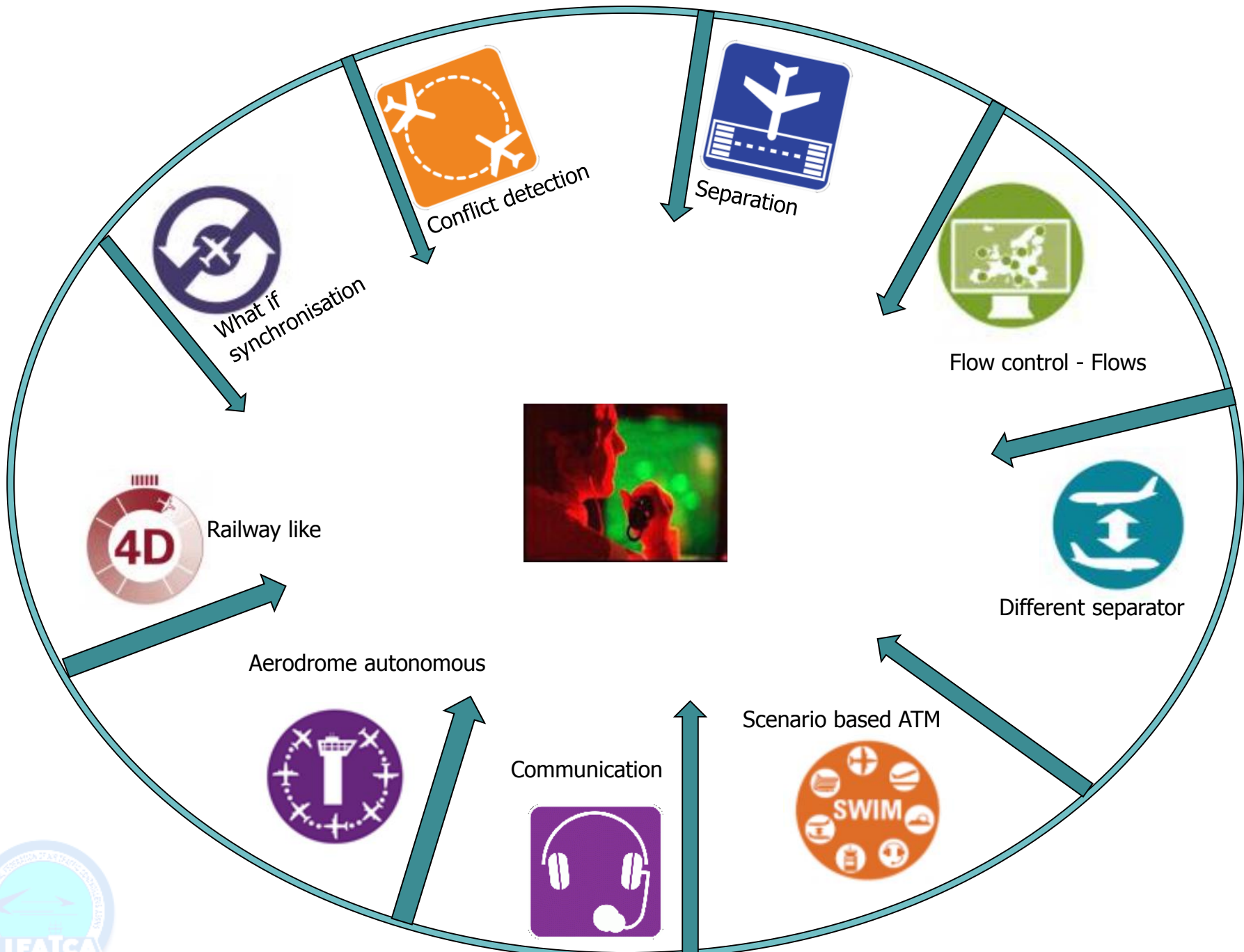
How does it currently work?



How does it currently work? Single European Sky context
Automation latitude







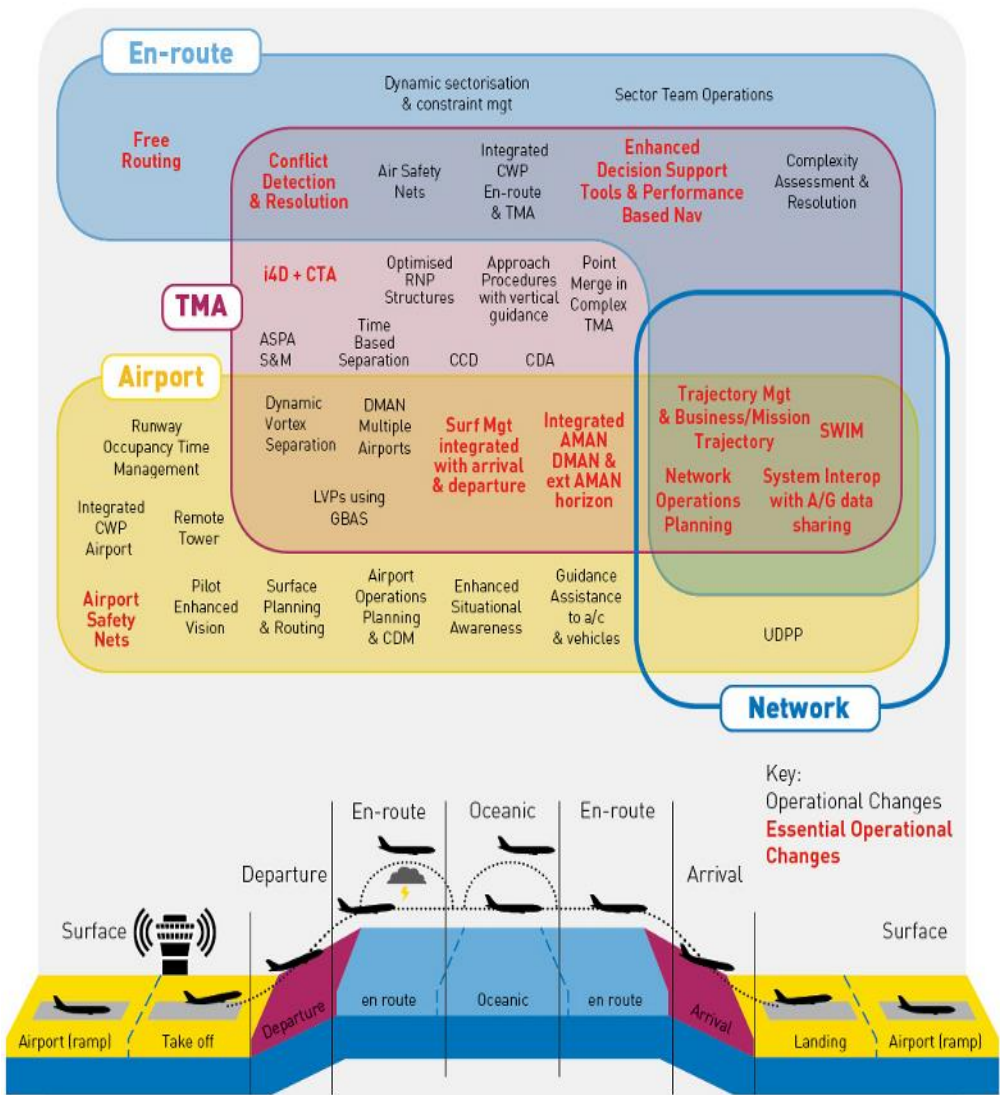


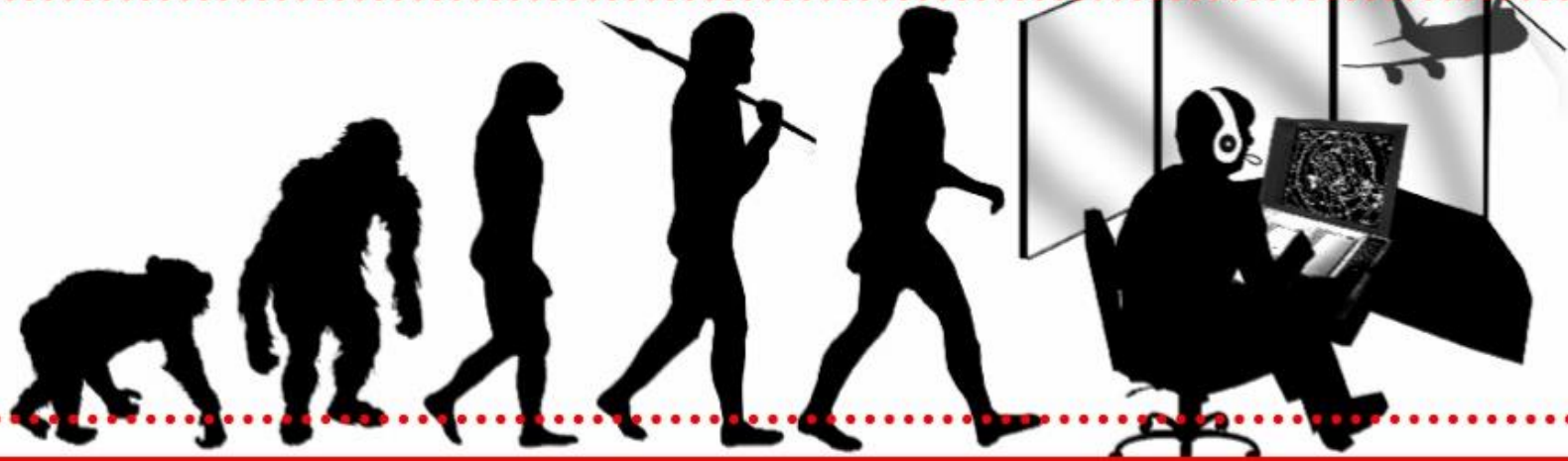
European ATM Master Plan

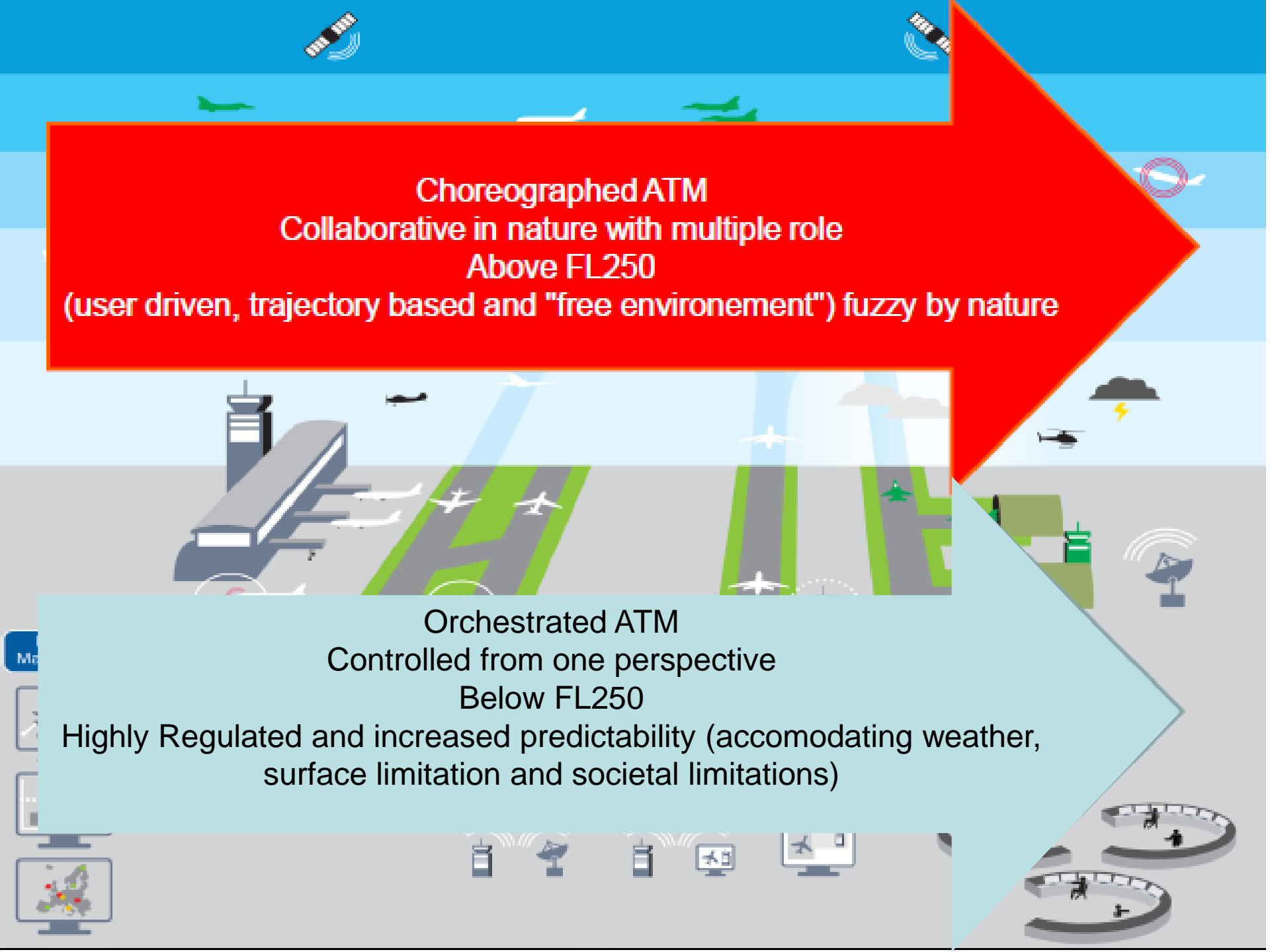
6 Key Features

Essential Operational Changes per Step and Feature

Key Feature	Deployment Baseline	Step 1 Time based	Step 2 Trajectory based	Step 3 Performance based
Moving from Airspace to 4D Trajectory Management	<ul style="list-style-type: none"> Civil/Military Airspace & Aeronautical Data Coordination A/G Datalink CPDLC 	<ul style="list-style-type: none"> Traj Mgt & BMT System Interop with A/G data sharing Free Routing 	<ul style="list-style-type: none"> Full 4D New A/G datalink Free Routing TMA exit to TMA entry 	
Traffic Synchronisation	<ul style="list-style-type: none"> Basic AMAN 	<ul style="list-style-type: none"> i4D + CTA Integrated AMAN DMAN & extended AMAN horizon 	<ul style="list-style-type: none"> Multiple CTDs/CTAs Mixed mode runway operations 	
Network Collaborative Management & Dynamic/Capacity Balancing	<ul style="list-style-type: none"> Basic Network Operations Planning 	<ul style="list-style-type: none"> Network Operations Planning 	<ul style="list-style-type: none"> Network Operations Planning using SBTs/RBTs 4D traj used in ATFCM UDPP 	
SWIM	<ul style="list-style-type: none"> Xchange models IP based network 	<ul style="list-style-type: none"> Initial SWIM Services 	<ul style="list-style-type: none"> Full SWIM Services 	
Airport Integration & Throughput	<ul style="list-style-type: none"> Airport CDM A-SMGCS L1 & L2 	<ul style="list-style-type: none"> Surface Management Integrated with arrival & departure Airport Safety Nets 	<ul style="list-style-type: none"> Further integration of surface & departure management A-SMGCS L3 & L4 	
Conflict Management & Automation	<ul style="list-style-type: none"> Initial Controller Assistance Tools 	<ul style="list-style-type: none"> Enhanced DST & PBN Conflict Detection & Resolution 	<ul style="list-style-type: none"> Advanced Controller Tools to support SBT/RBT Enhanced trajectory prediction 	

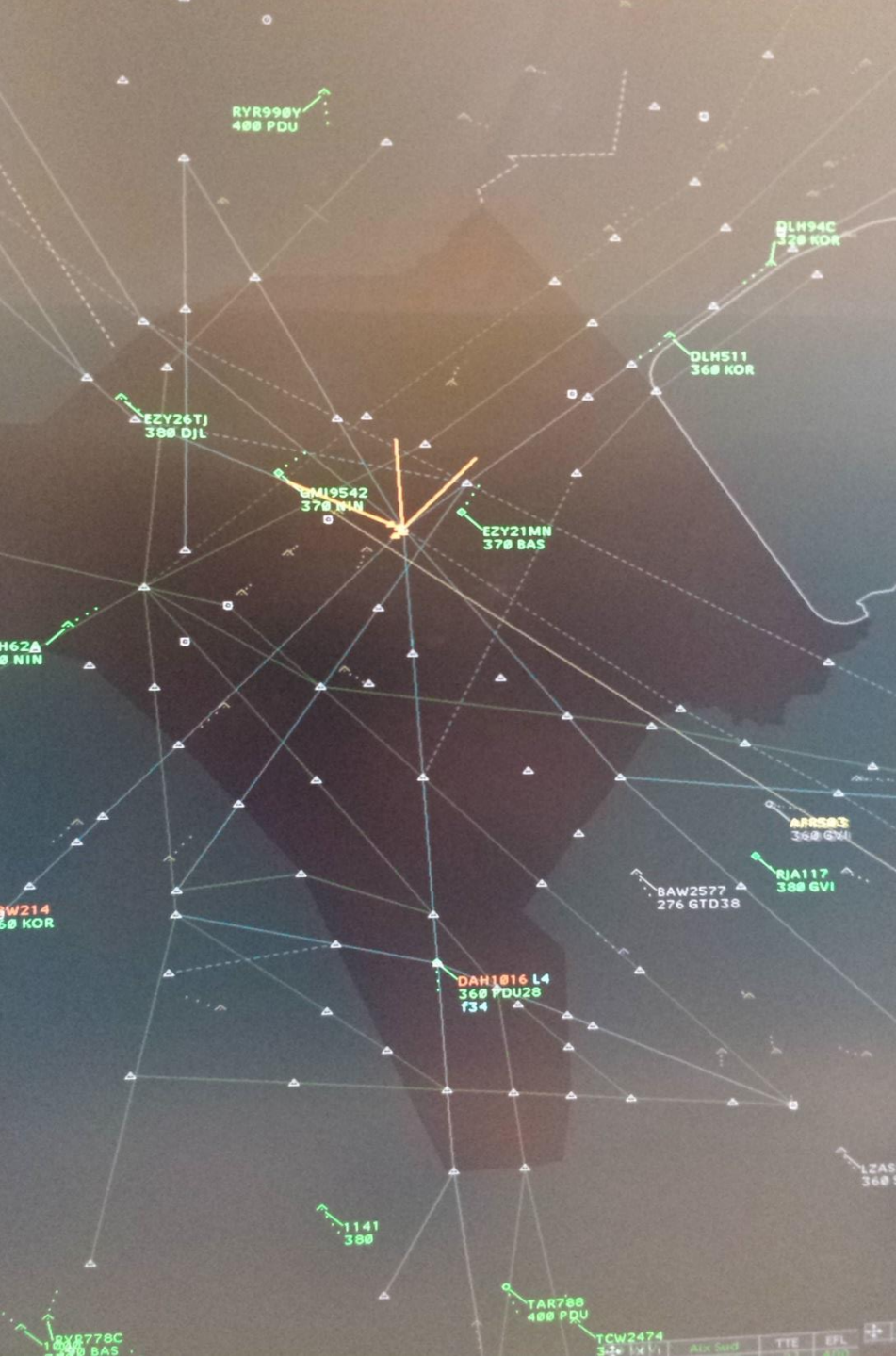






Choreographed ATM
Collaborative in nature with multiple role
Above FL250
(user driven, trajectory based and "free environment") fuzzy by nature

Orchestrated ATM
Controlled from one perspective
Below FL250
Highly Regulated and increased predictability (accommodating weather, surface limitation and societal limitations)



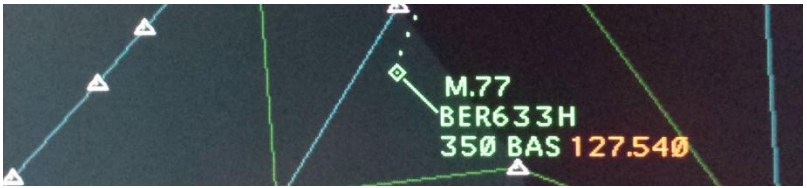
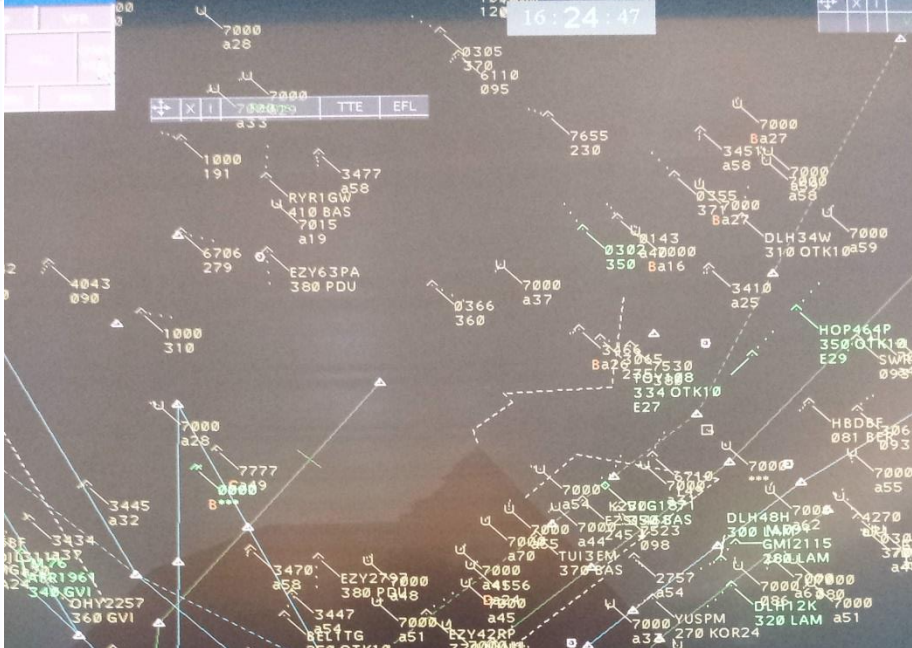
BAS	ETX	EFL	XFL	pf1	RFL	Type	ADEP	ADES
BER221G	05:17:30		390			A320	EDDL	LEPA
SWR149D	05:18:45	090	150		330	A319	LSGG	LEBL
GW107E	05:18:45		370		390	A320	EDDS	LEBL
BER101Q	05:21:37		370			A320	EDDT	LEPA
BER3280	05:21:59		350		370	A320	EDDH	LEIB
VLG7893	05:23:50		370			A320	ULLI	LEBL
BER930V	05:24:31		350			A321	EDDV	LEPA
CFG2KP	05:27:29	350	330		350	A321	EDDV	LEPA
GMI2802	05:27:42	370	370		390	A319	EDDW	LEIB
BER446Z	05:27:43		350			A321	EDDL	LEPA
GW13V	05:29:17		350			A320	EDDL	LEPA
EZY31HE	05:30:42		370			A320	EDDB	LEPA
TJTDKIN	05:31:34		230			B190	LFJL	LFML
HAY2402	05:32:16	310	330			A320	EDNY	LEPA
GMI4570	05:32:29		350	310	370	A321	EDDW	LEPA
CFG2M	05:32:39		350		370	A321	EDDB	LEPA
DLH17Y	05:33:26		330		350	CRJ9	EDDM	LFML
DLH04M	05:33:52		390			A319	EDDM	LEBL
HO520AD	05:36:08		290			E170	LFST	LFML
BER3274	05:40:06		370			A320	EDDH	LEPA

KOR/AZB

HST	(15Nm)			
370	DLH04J	FIN4PD	13.2	00'00
370	RYR26JT	QAJ898	14.9	00'00
370	QAJ898	DLH04J	6.6	00'40
370	QAJ898	FIN4PD	14.5	04'56
370	DLH94C	EIN40G	1.5	06'20
370	DLH94C	EIN43K	12.9	12'05

- DJL -

SRN



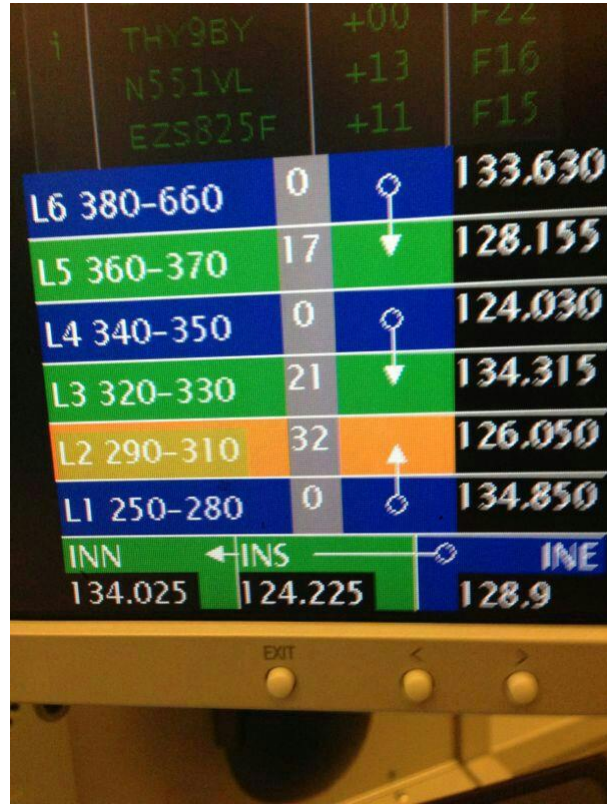
GOOD · CHEER · NUMBER

GOOD HOUSEKEEPING

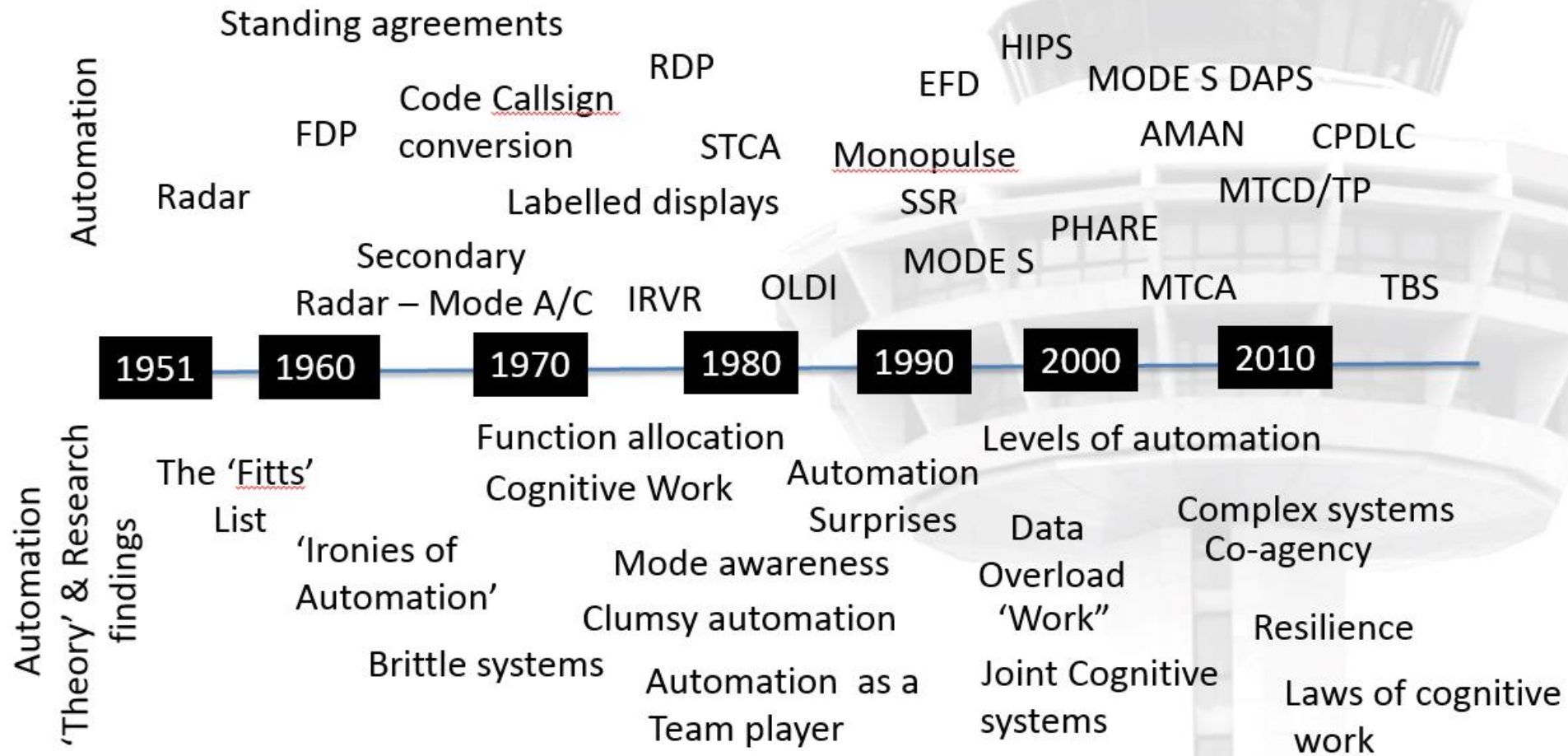
\$1.00 A YEAR

AUGUST '08

New York THE PHELPS PUBLISHING CO. Springfield, Mass. Chicago



Automation in ATM



Source: A.Smoker

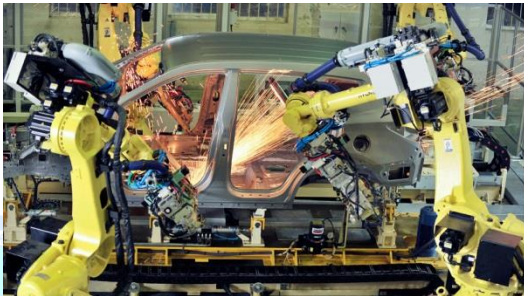




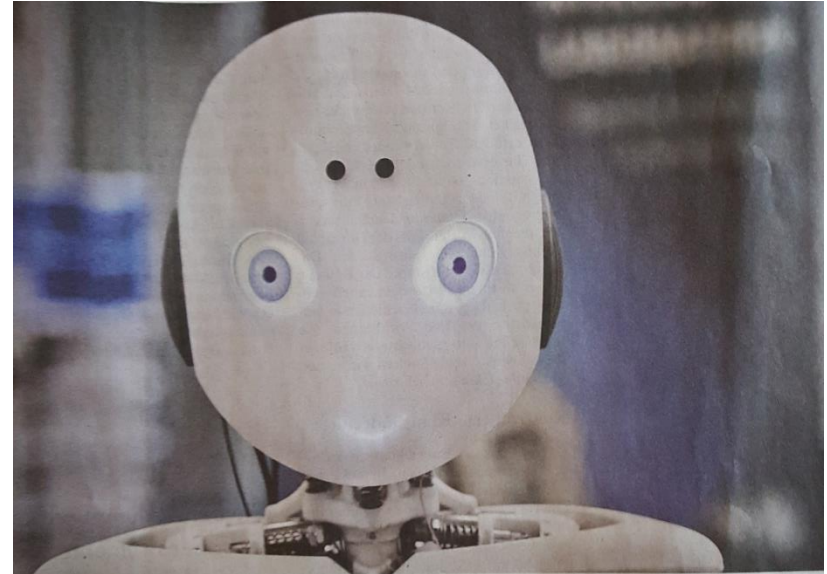
It is evident that there are numerous misconceptions about the role and place that automation plays in new designs. The consequences, which are experienced by many controllers, pilots and engineers day in and day out often stem directly from these. Bradshaw et al (Bradshaw, 2013) refer to some of these as the “Seven deadly myths of “Autonomous Systems”:



MYTH VS REALITY



Future role of the human?



Roboter Roboy Universität Zürich



interoperability were main contributors to the ICAO GANP/ASBU modules and continue to support ICAO through their latest results, shared and joint positions and close cooperation with other regions of the world.

4.7 Role of the human

4.7.1 Integrated view of the ATM system

Developing and realising the ideas included in the Master Plan will only be successful by recognising the Human actors as an integral part of the overall ATM system, and as the most critical source of its performance, safety and resilience. As in past and present operations, ATM performance will remain the result of a well-designed interaction between Human, procedural, technological, environmental, organisational, and other elements. Given the expected increase in capacity and complexity of European ATM, SESAR will only succeed when the design is understood from an overall system view. The nature and unique adaptability of Human performance will, according to the SESAR operational concept, enable the ATM system to react to variability in operational conditions and other non-standard situations. However, due to the increasing degree of automation support, the interaction between Humans and systems as well as between various Human roles will continuously change, aiming at safe, secure and effective operations under high capacity in the constrained environment of European airspace and aerodromes.

Around 300,000 operational staff across the aviation sector will be affected by the realisation of the Master Plan. Although this is expected to mostly affect Air Traffic Controllers, Pilots, avionics engineers, ATSEP (Air Traffic Safety Electronics Personnel), and dispatch roles, the impact on all operational roles should be considered in the development and deployment process. The immense amount of automation and other advanced tools will not only affect operational work itself but will also have a major impact on all engineering roles in the system.

To support Human system integration it is key that:

- designs incorporate an understanding of how human and system actors work together,
- designs explicitly incorporate the requirements that enable all functions to work collaboratively in managing:
 - performance variability and system resilience, aiming at sustaining the defined performance;
 - a systematic change management approach to development, deployment and validation.

In the SESAR project, Human system integration is supported by a comprehensive Safety Assessment approach as well as a systematic analysis and management of Human Factors aspects in the design and validation of future operations, encompassing elements of Resilience Engineering. A set of methods and tools has been developed to support this integration.

Change in role	Emergent property
Demanding higher skills and levels of performance	Exceeds human capability
Reducing operating tasks to passive monitoring	Deskilling, tedium, low system comprehension, leading to low morale,
Automating functions	Reduces ability to intervene
Reduces humans ability to deal with the unexpected	

**Requirements for Effective Function Allocation:
A Critical Review**

2014

Karen M. Feigh and Amy R. Pritchett, Georgia Institute of Technology, Atlanta

Brief Paper

Ironies of Automation*

1983

LISANNE BAINBRIDGE†

Key Words—Control engineering computer applications; man-machine systems; on-line operation; process control; system failure and recovery.

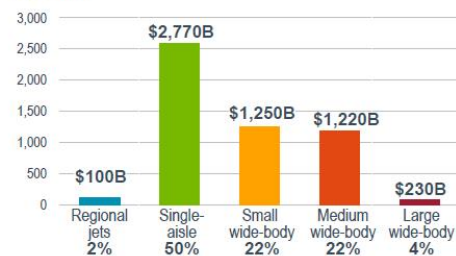


38,000 new airplanes are valued at \$5.6 trillion



Airplane deliveries: \$5.6 trillion

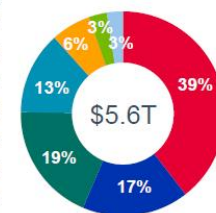
2015 - 2034



New airplane values by region

2015 - 2034

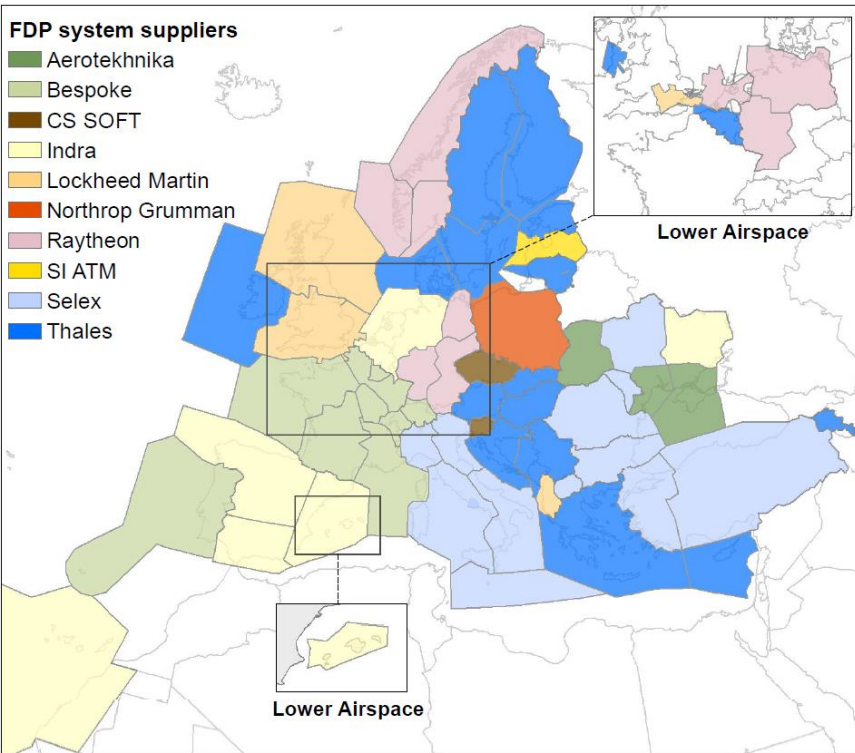
Region	Airplanes
Asia	\$2,200B
North America	\$940B
Europe	\$1,050B
Middle East	\$730B
Latin America	\$350B
Africa	\$160B
C.I.S.	\$140B
World Total	\$5,570B



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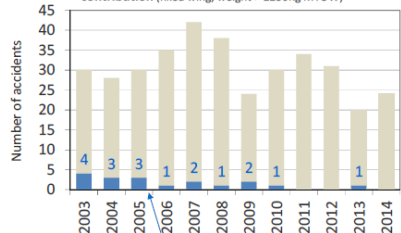
FDP system suppliers

- Aerotekhnika
- Bespoke
- CS SOFT
- Indra
- Lockheed Martin
- Northrop Grumman
- Raytheon
- SI ATM
- Selex
- Thales



New Risks in ATM? – Emergent proprieties – Resilience?

Total commercial air transport (CAT) accidents and accidents with ANS contribution (fixed wing, weight > 2250kg MTOW)



Source: EASA

Accidents with ANS contribution

Air traffic control over southern England and Wales



Source: NATS

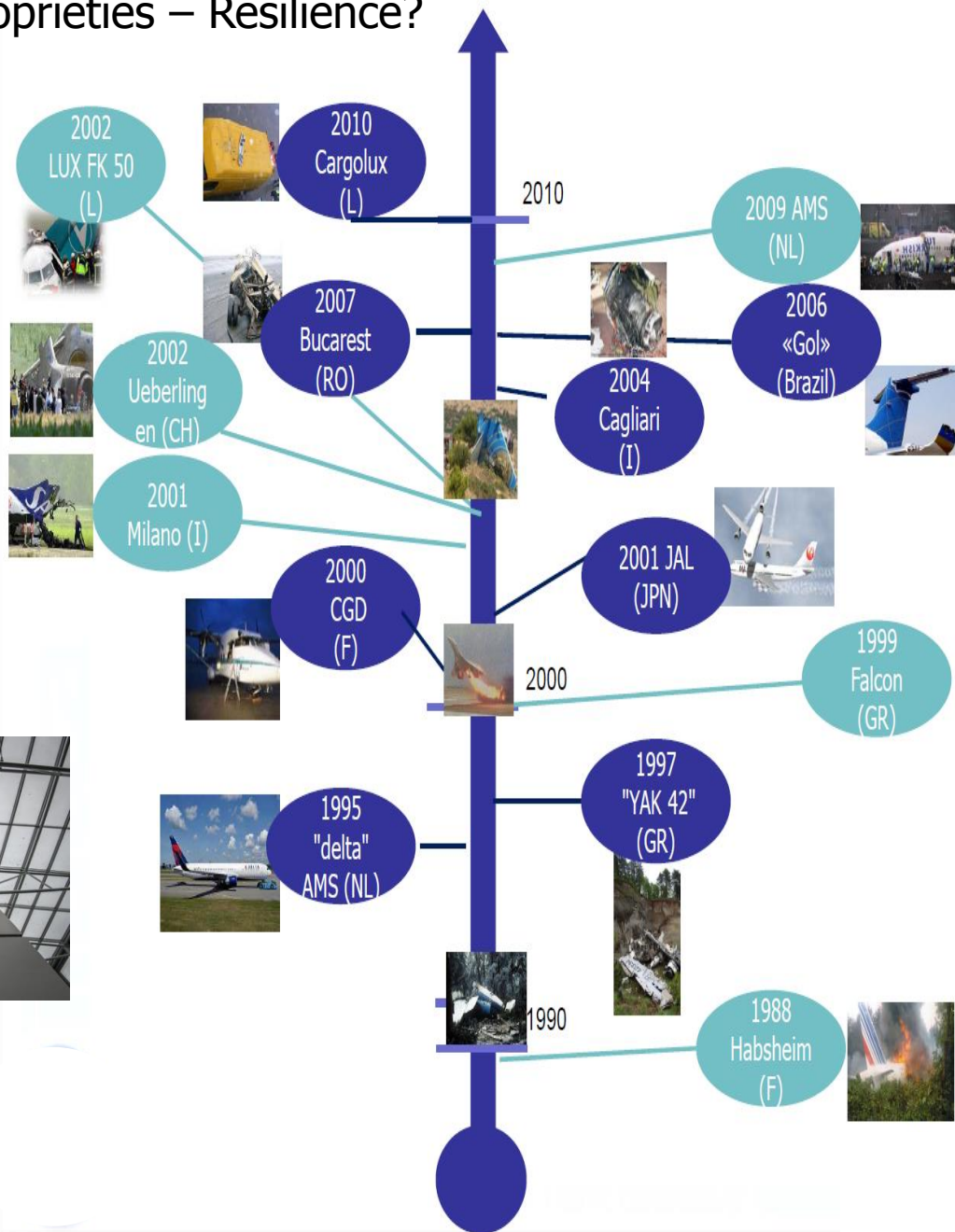
BBC

12.12.2014

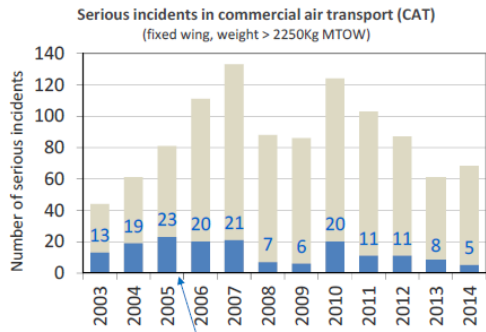
June/ July 2014



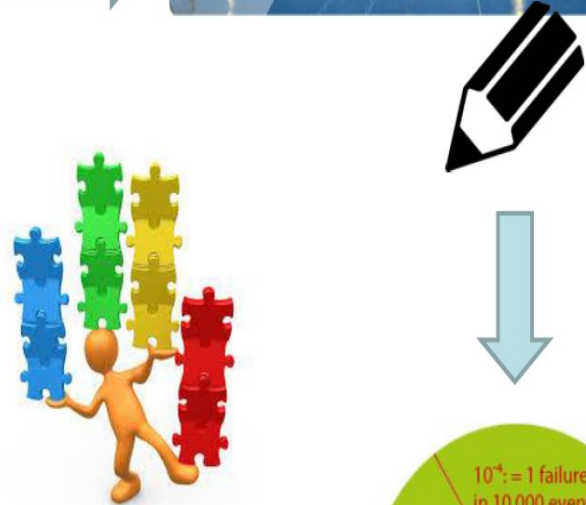
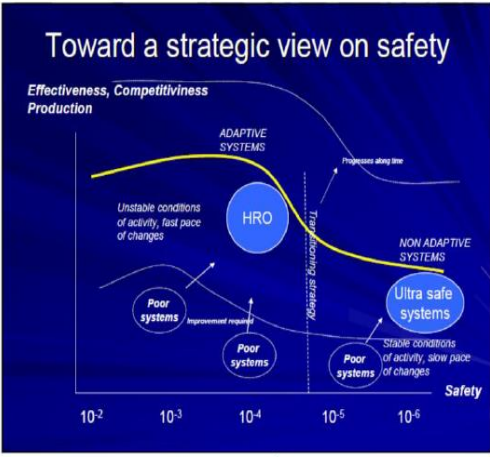
29.05.2015



....too Safe?



Source: EASA
 Figure 2-12: Serious Incidents in EUROCONTROL area with ANS contribution (2003-14)



PROBLEM/CHALLENGE

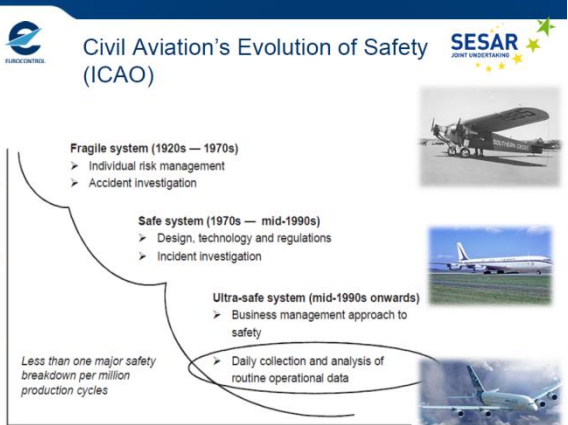
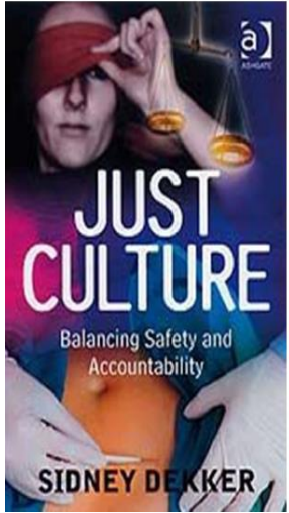
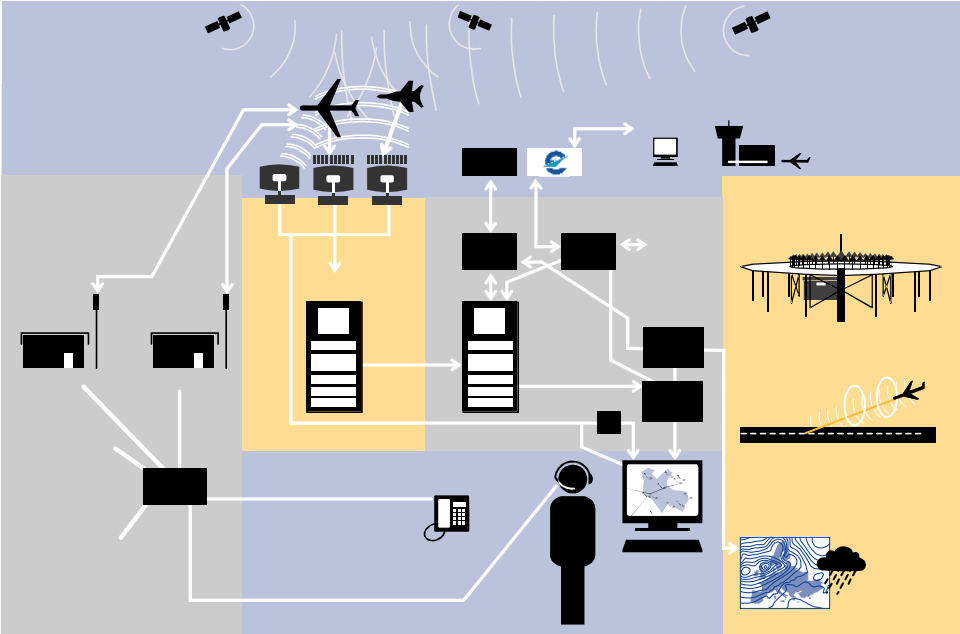


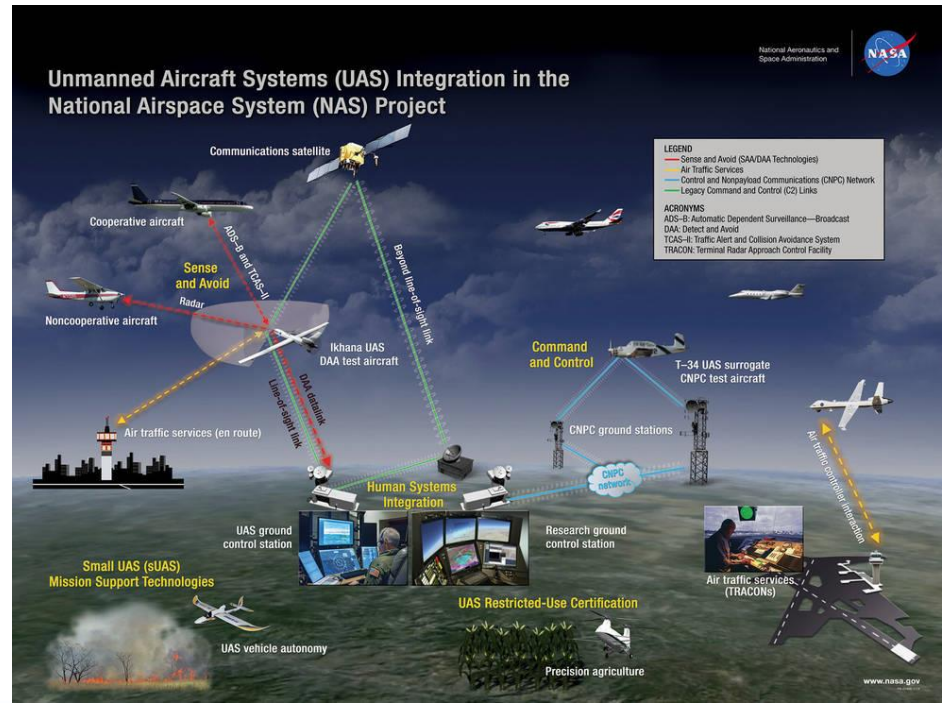
Figure 2: The imbalance between things that go right and things that go wrong



OUTLOOK

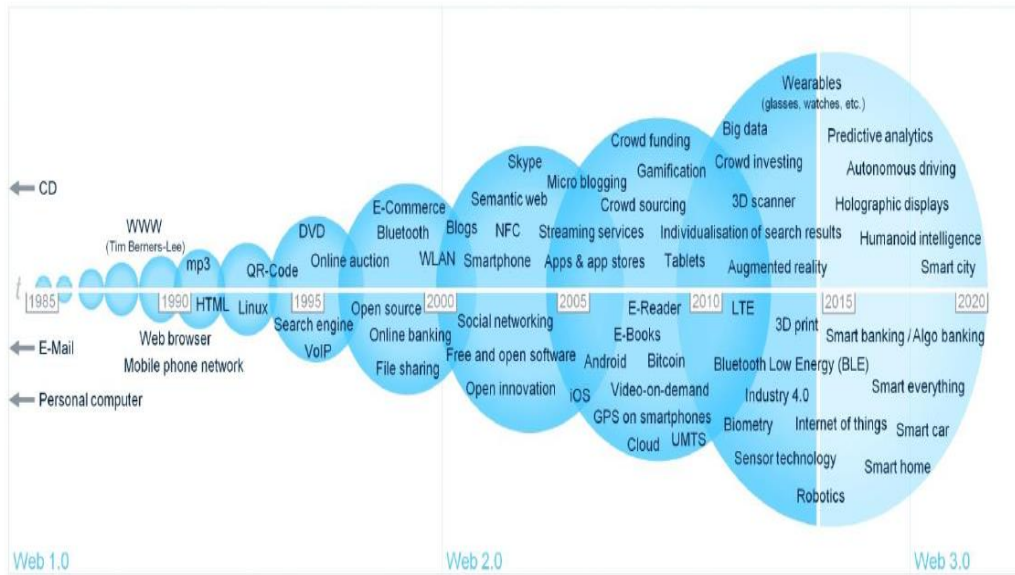


.... Classical way





**Welcome to
the Digital Revolution**



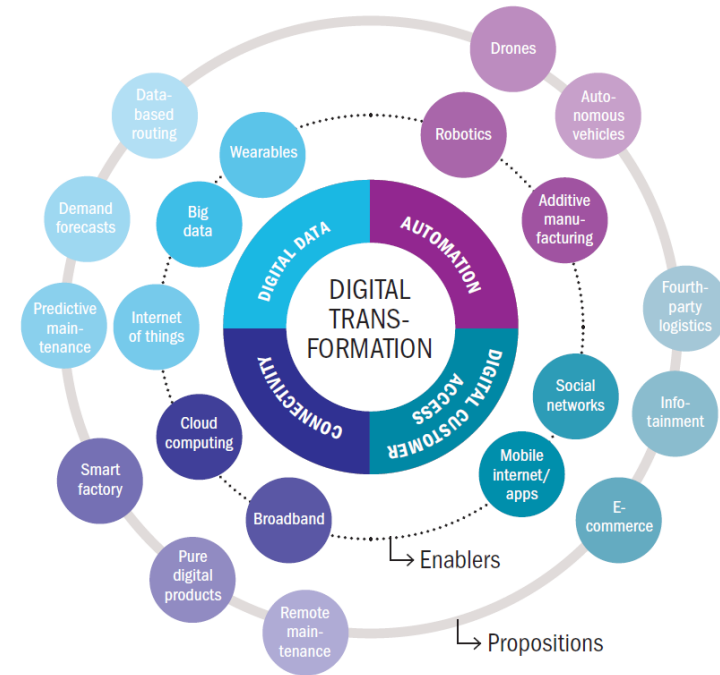
reduction in product life cycles & increase in innovation intensity →

Graph: Oliver Ullmann, Deutsche Bank Research.

Source: Dapp, T. (2014). Fintech – The digital (r)evolution in the financial sector: Algorithm-based banking with the human touch. Deutsche Bank Research. Frankfurt am Main.

ESSENTIALLY, THE DIGITAL TRANSFORMATION TAKES EFFECT VIA FOUR LEVERS THAT ARE SUPPORTED BY NEW ENABLERS AND PROPOSITIONS

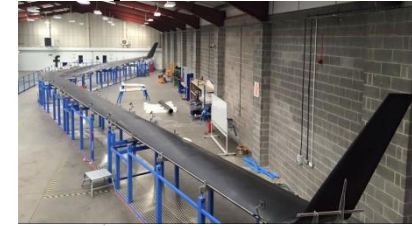
Drivers of digitization

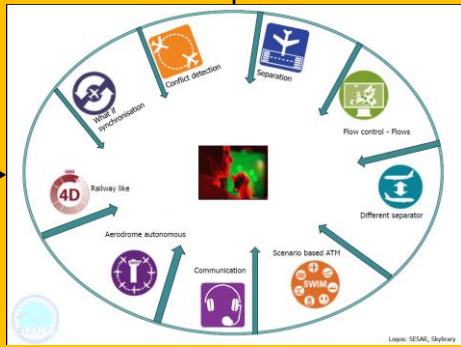


Source: Roland Berger

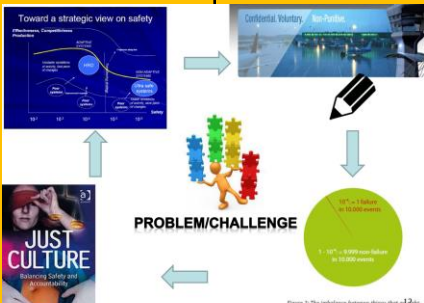
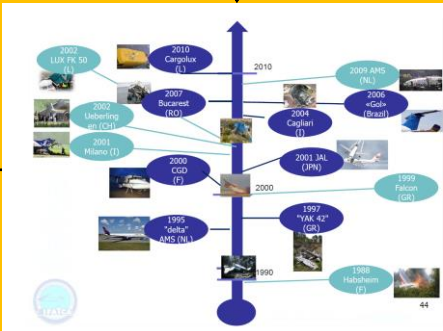
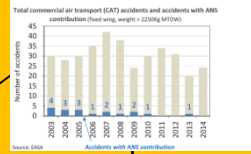
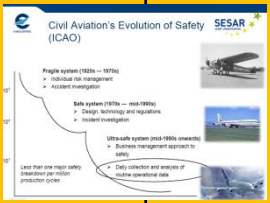
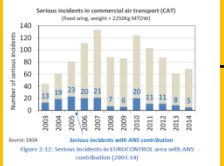


ATM 4.0





Assesment from an ATCO Point of view





Thanks

Sesar.coord@ifatca.org
Marc.baumgartner@skyguide.ch



Reading/INFO Material

HUMAN-CENTERED COMPUTING
 Editors: Robert S. Hoffman, Jeffrey M. Bradshaw, and Ken Ford, Florida Institute for Human and Machine Cognition, rshoffman@fhmc.us

The Seven Deadly Myths of "Autonomous Systems"
 Jeffrey M. Bradshaw, Robert R. Hoffman, Matthew Johnson, and David D. Woods

Free Flight

Automation Tools for Controllers in Future Air Traffic Control
 Raja Parasuraman, Jacqueline Duley, & Anthony Smoker
 Cognitive Science Laboratory, The

As the 21st century draws near, commercial air travel can look back on almost 100 years of service with some satisfaction for its excellent safety record. However, the volume of air traffic is likely to double over the next two decades, posing a threat to the capacity of the air traffic control (ATC) system [1,2]. Moreover, even if the accident

LOAs - 1st review

Some Challenges in the Design of Human-Automation Interaction for Safety-Critical Systems
 Michael Feary^a and Emilie Roth^b

^a National Aeronautics and Space Administration
 Ames Research Center
 Moffett Field, CA, 94035, USA

^b Roth Cognitive Engineering
 2 Olver Court
 Menlo Park, CA, 94025

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NOVEMBER 2014

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Making effective use of technology in SESAR deployment

Editors: Matthias Finger, Nadia Bert, David Kupfer

Highlights

The 6th Florence Air Forum focussed on the upcoming Deployment Phase of the EU's Research Program for Air Traffic Management SESAR. Some of the most relevant decision makers and leading experts came together to discuss the issue; among others Florian Guillermet, Director of the SESAR Joint Undertaking, Frank Brenner, Director General of Eurocontrol, Maurizio Castelletti, Head of Unit Single European Sky of the European Commission, and Prof Kenneth Button, Aviation expert and advisor of ESD Transport for Air Transport and Aviation

DISRUPTION TO UK AIR TRAFFIC MANAGEMENT ON 12TH DECEMBER 2014: ANALYSIS AND LESSONS LEARNT
 J.A. McDermid*, P.J. Whysall†

* University of York, UK, Department of Computer Science, Deramore Lane, York, YO10 5GH, John.McDermid@york.ac.uk

Reliability Engineering and System Safety
 journal homepage: www.elsevier.com/locate/ress

The use of Functional Resonance Analysis Method (FRAM) in a mid-air collision to understand some characteristics of the air traffic management system resilience
 Paulo Victor Rodrigues de Carvalho*

Neither Pollyanna nor Chicken Little
 Thoughts on the Ethics of Automation

C. Michael Holloway
 NASA Langley Research Center
 Hampton, VA, USA

John C. Knight
 University of Virginia
 Charlottesville, VA, USA

John A. McDermid
 University of York
 York, UK

Some Lessons Learned About Flight Deck Automated Systems

Federal Aviation Administration

Kathy Abbott, PhD, FRAeS
 Federal Aviation Administration
 2 June 2015

From Safety-I to Safety-II
 A White Paper

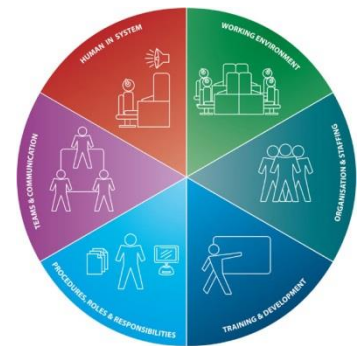
From Safety-I to Safety-II
 A White Paper

Lloyd's Register Foundation

Foresight review of resilience engineering
 Designing for the expected and unexpected

AUTONOMY RESEARCH FOR CIVIL AVIATION
 TOWARD A NEW ERA OF FLIGHT

Committee on Autonomy Research for Civil Aviation
 Aeronautics and Space Engineering Board
 Division on Engineering and Physical Sciences
 NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES



<http://nats.aero/blog/2014/08/glimpse-future>