Supporting
European
Aviation

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Stepping stones towards a safe AI in aviation

MONDAIS Webinar

1rst of March 2021

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FOUNDING MEMBER SESAR JOINT UNDERTAKING

NETWORK MANAGER

Safety Critical systems

A **safety-critical system** is a system whose failure or malfunction may result in one (or more) of the following outcomes: death or serious injury to people, loss or severe damage to equipment / property, or environmental harm.

Regulation and Standards

Safety in aviation … as well for AI!

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Safety Case is a structured argument, supported by evidence, intended to justify that a system is acceptably safe for a specific application in a specific operating environment.

European Aviation AI High Level Group

Scope : Aviation / Air Traffic Management

Focus : what we can do TODAY

Demystify AI

Promote AI based applications and its benefits

Identify Business Challenges

Recommendations to accelerate AI uptake


EUROPEAN AVIATION ARTIFICIAL INTELLIGENCE HIGH LEVEL GROUP

The FLY AI Report

Demystifying and Accelerating AI in Aviation/ATM

5th March 2020

WITH INPUTS FROM EDA MILITARY EXPERTS AND NATO ATTENDING IN AN OBSERVING CAPACITY

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EUROCONTROL On-going activities

Data and AI-infrastructure framework	■ A federated data foundation and AI-infrastructure should be established
Research and Innovation	■ Further exploration of the potential of AI in aviation/ATM should be strengthened in areas of: ■ high impact on aviation/ATM performance and environment ■ human-machine collaboration ■ safety-critical operations ■ safety intelligence tools and cyber threat intelligence services
Validation and Standards	■ Appropriate AI validation methods and tools should be developed as well as standards and guidelines
Deployment	■ The rapid uptake of AI-based solution in operations should be encouraged in the cybersecurity domain and non-safety critical operations ■ European aviation/ATM actors should aim to reduce AI-developments time to market.
Communication and Dissemination	■ Communication on AI should be enhanced ■ Dissemination of AI benefits and lessons learned should be strengthened ■ AI aviation/ATM applications developments and deployments should be regularly scouted
Training and Change Management	■ An AI culture through training/re/upskilling and change management should be developed
Partnership	■ The aviation/ATM community should build-up an inclusive AI aviation/ATM partnership

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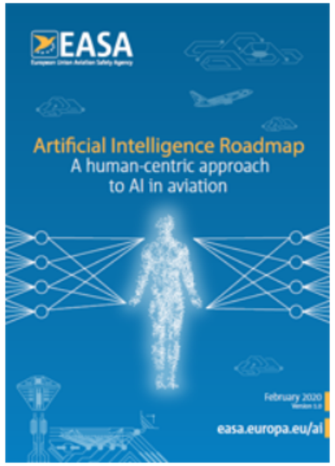
EUROCAE

WG-114 | Artificial Intelligence

SAE INTERNATIONAL

G-34, Artificial Intelligence in Aviation

AS6983: Process Standard for Development and Certification/Approval of Aeronautical Safety-Related Products Implementing AI



ECTL-EASA Cooperation on AI

Support to Guidance on AI

Use Cases proposed by ECTL

- Pre-tactical Forecasting
- Climb & Descend
- Network congestion Detection
- Network congestion Resolution
- Time Based Separation

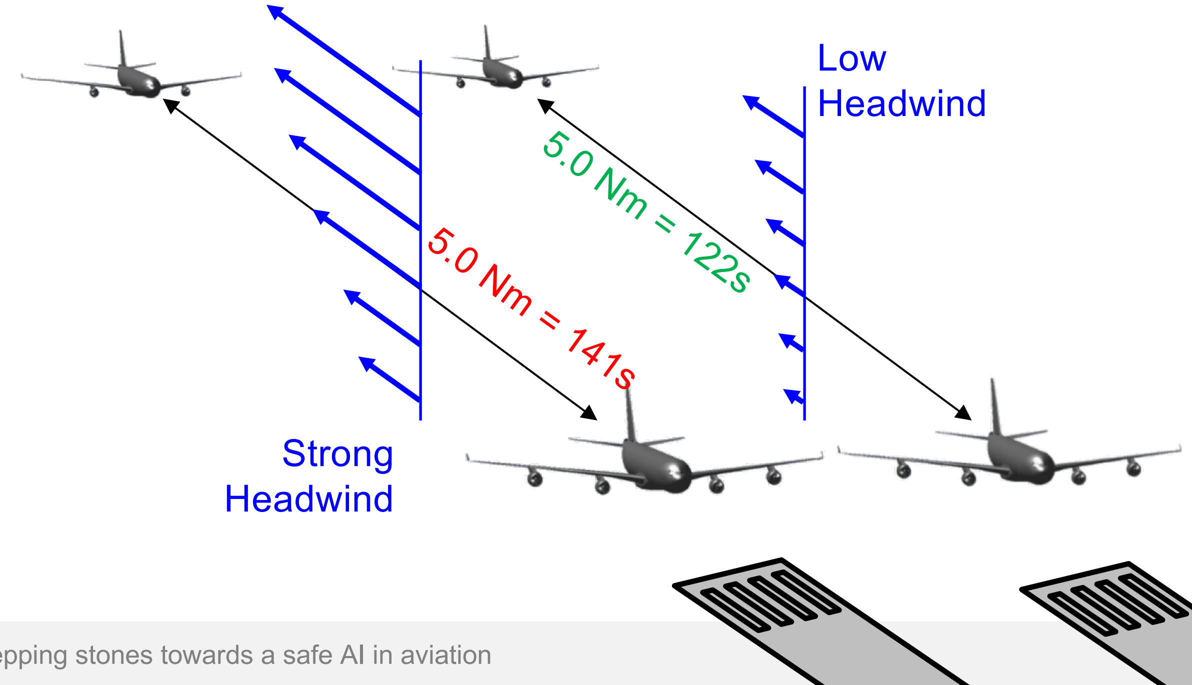
Separation based on time in place of distance

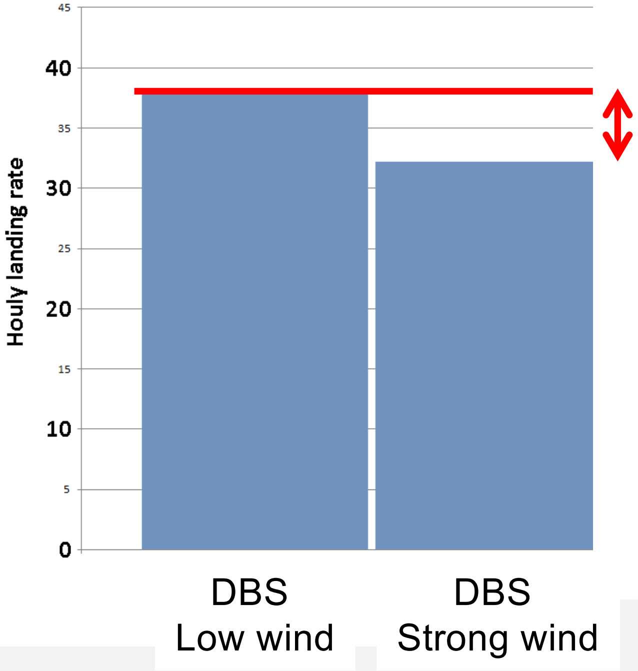
Time Based Separation - TBS

Source: F.Rooseleer, R.Barragan, I.DeVisscher

Time Based Separation (TBS) permits the adaptation of separations to improve runway throughput in strong headwind conditions

- Strong headwind increases time separation for constant distance applied





Separation based on time in place of distance

Time Based Separation - TBS

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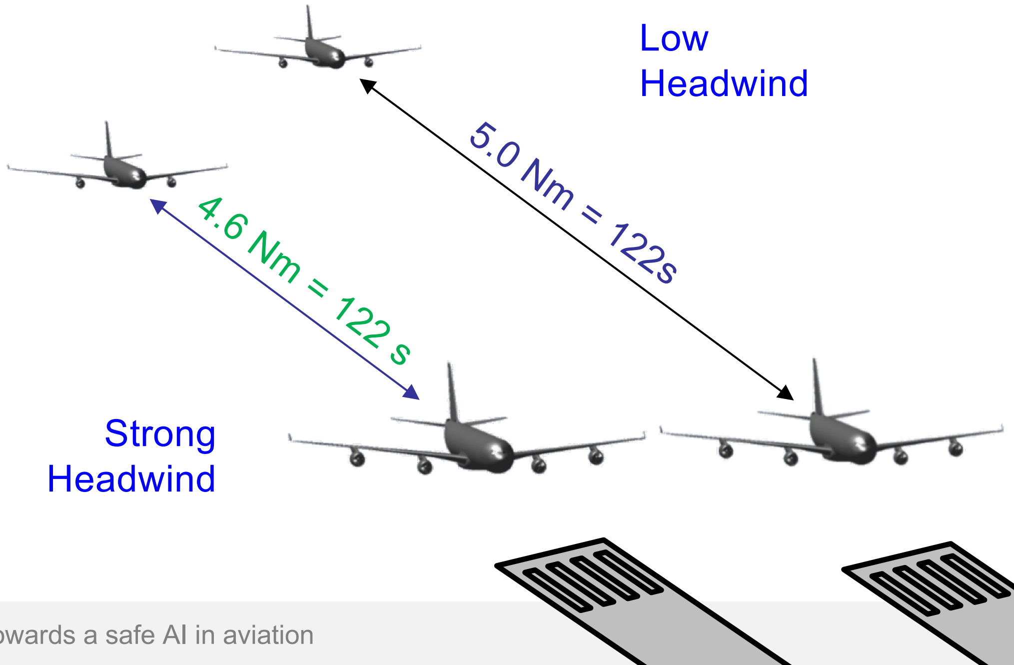
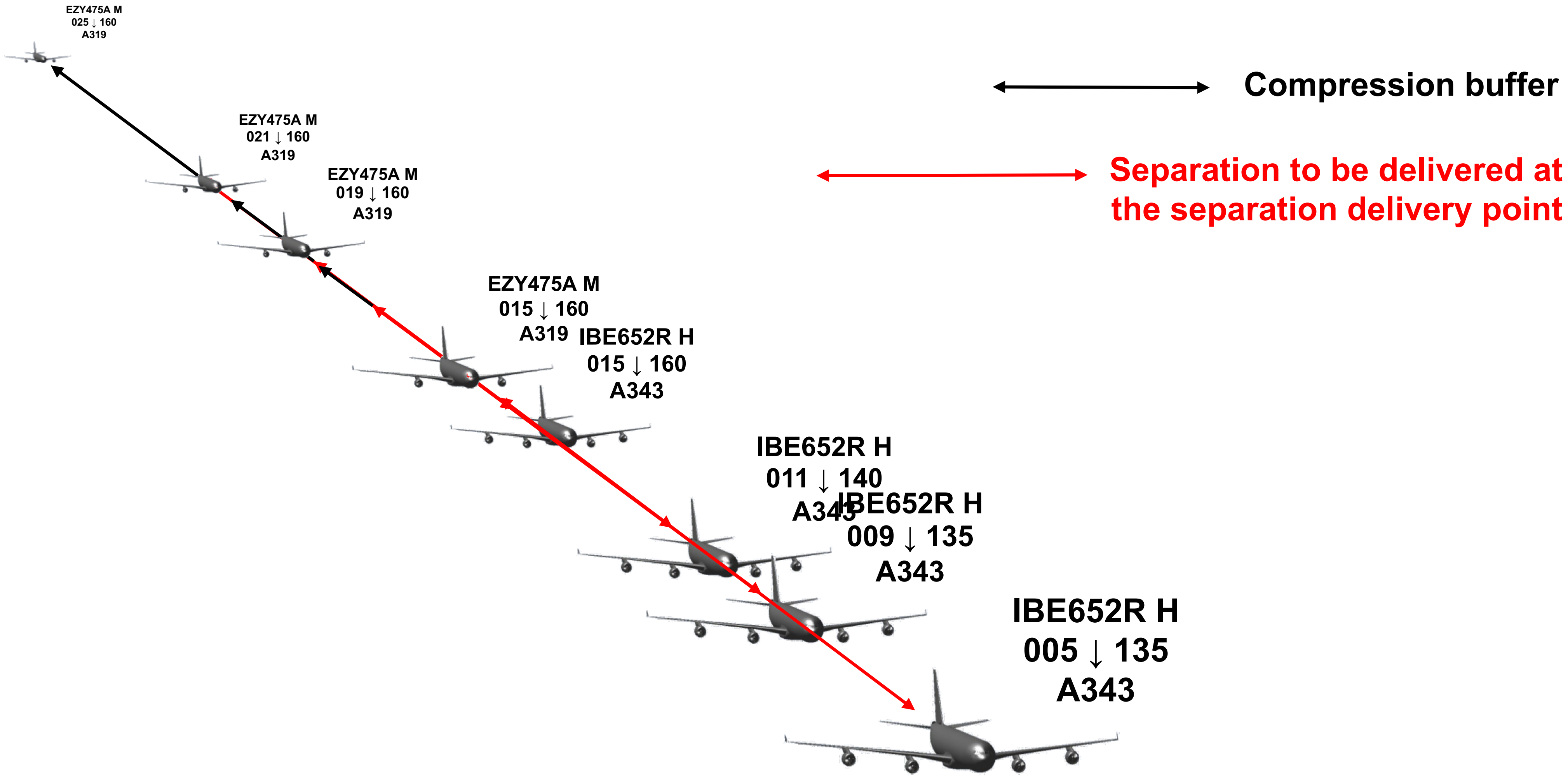


- Strong headwind increases time separation for constant distance applied
- Reduced separations support constant time between 2 landings in strong headwind conditions

Separation based on time in place of distance
Optimised Runway Delivery - ORD

Source: F.Rooseleer, R.Barragan, I.DeVisscher



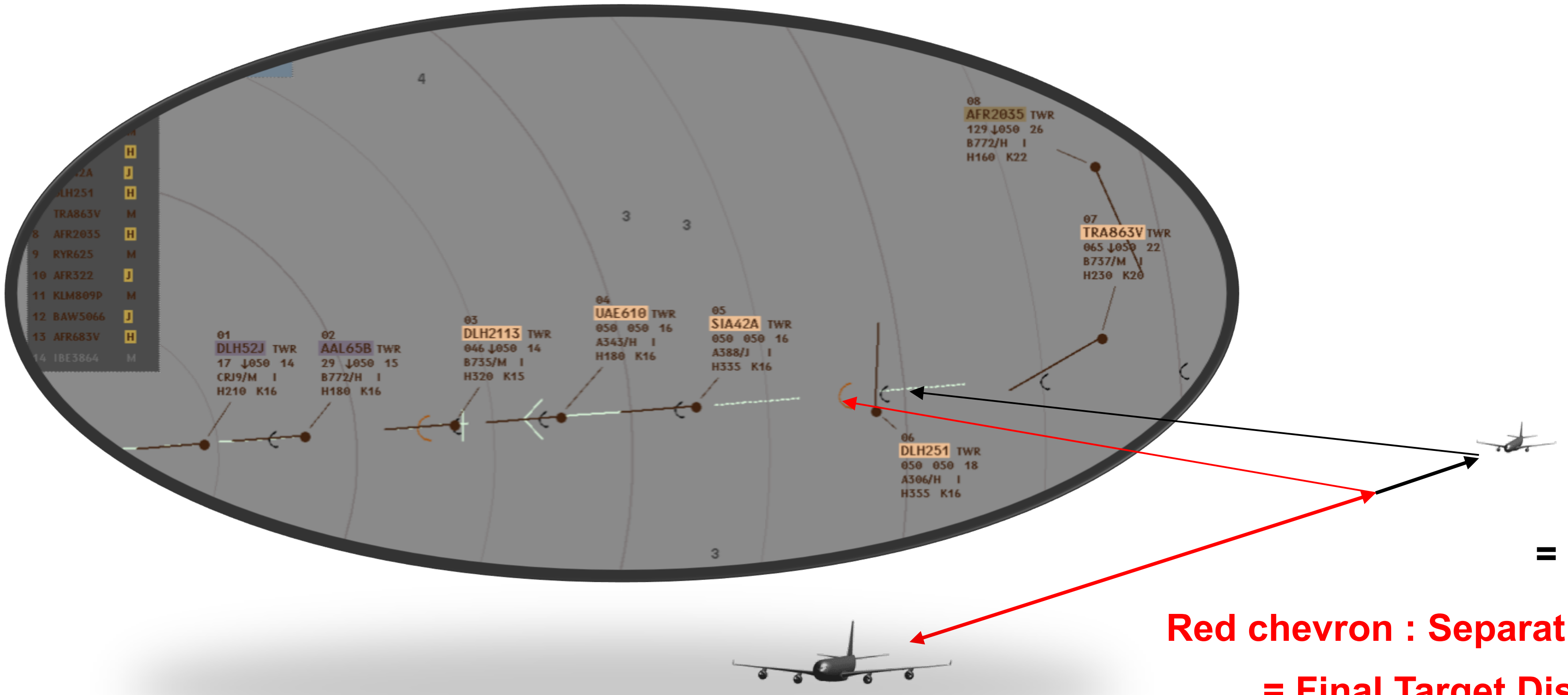
Calibration of Optimised Approach Spacing Tool - COAST

Source: F.Rooseleer, R.Barragan, I.DeVisscher

TBS delivery necessitates Distance Indicators

ATCOs applies separation buffers by experience during spacing at interception for ensuring separation compliance (still with margins) at threshold

TBS can be completed by ORD = Optimum Runway Delivery for more efficient management of compression buffers based on prediction



Black Chevron: Compression buffer = Initial Target Distance (ORD or ITD)

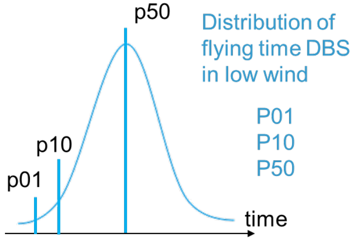
Red chevron : Separation to be delivered = Final Target Distance (TBS or FTD)

Computation of TBS Indicator

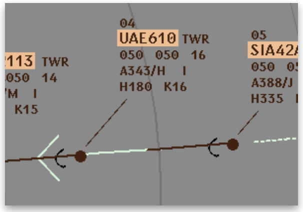
Time Based Separation - TBS

Source: F.Rooseleer, R.Barragan, I.DeVisscher

TBS minima



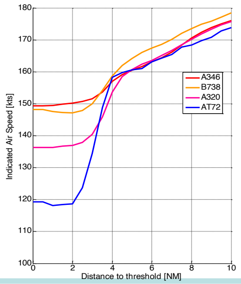
Aircraft pair



Target Distance (TD)

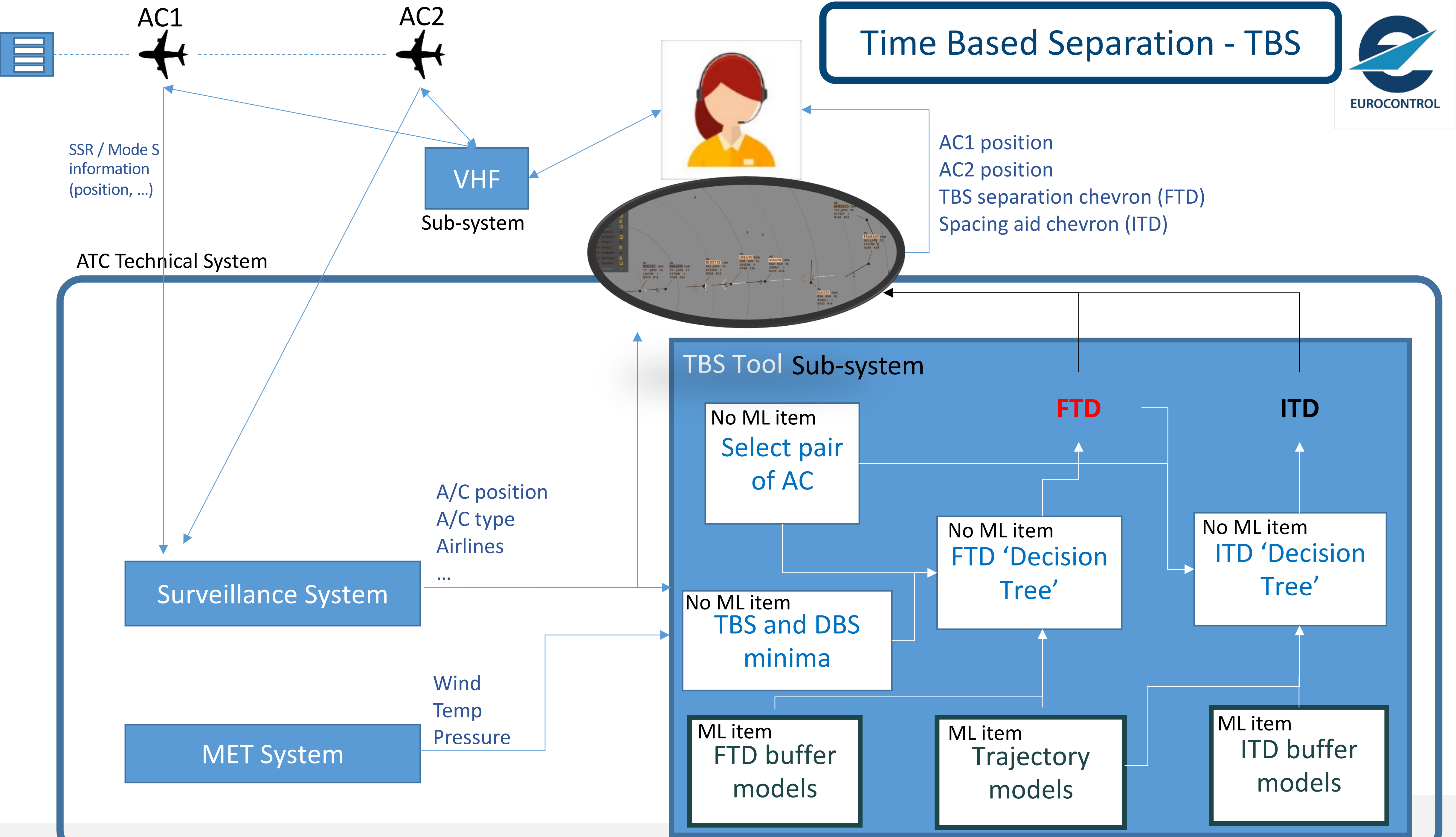
Sources of uncertainties

Follower Aircraft speed profile



Met

Need for accurate prediction


Time Based Separation - TBS
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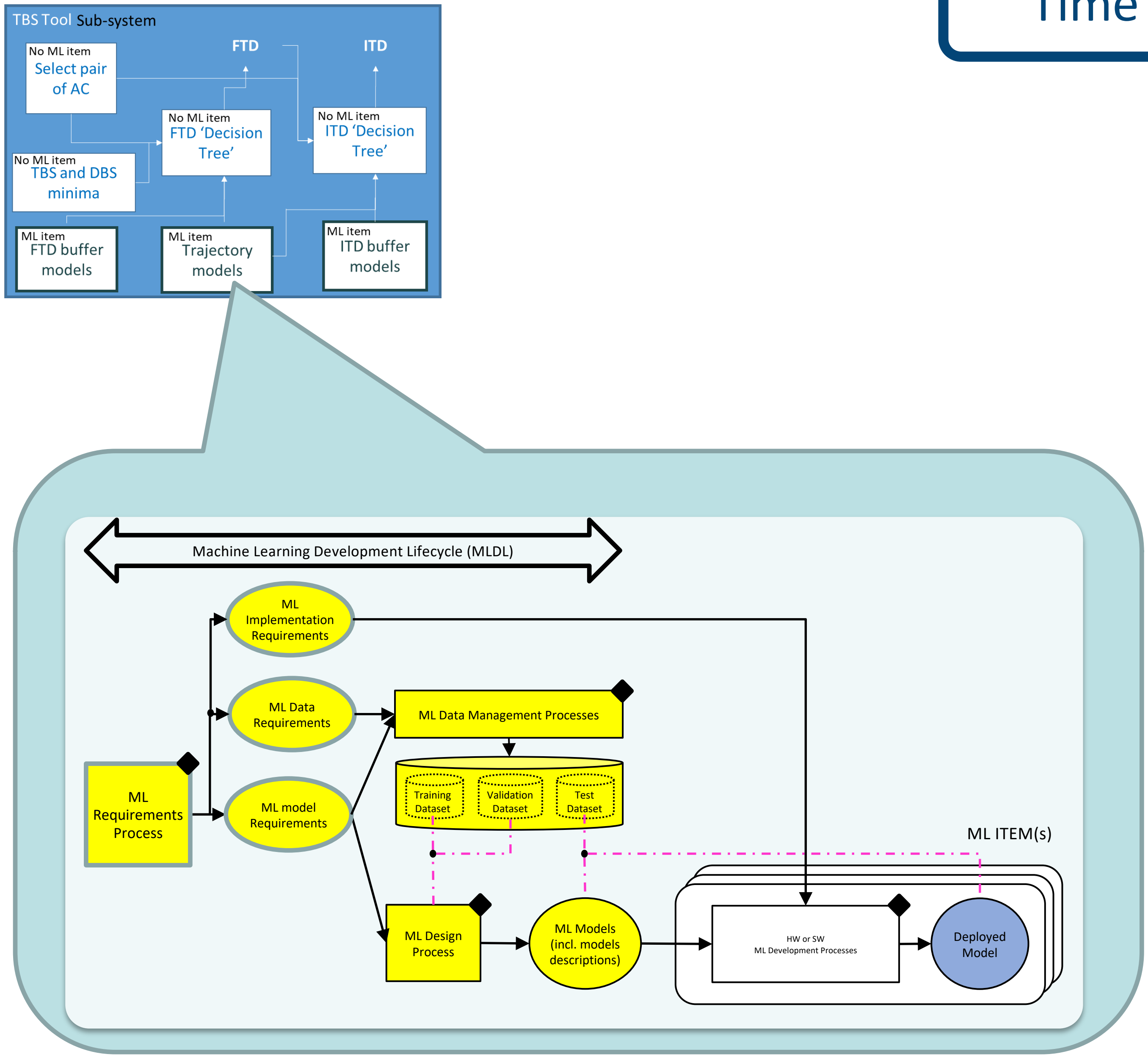
AC1
AC2
SSR / Mode S information (position, …)
VHF
Sub-system
ATC Technical System
AC1 position
AC2 position
TBS separation chevron (FTD)
Spacing aid chevron (ITD)
TBS Tool Sub-system
FTD
ITD
No ML item
Select pair of AC
No ML item
FTD 'Decision Tree'
No ML item
ITD 'Decision Tree'
No ML item
TBS and DBS minima
ML item
FTD buffer models
ML item
Trajectory models
ML item
ITD buffer models
A/C position
A/C type
Airlines
…
Surveillance System
Wind
Temp
Pressure
MET System

Time Based Separation - TBS



Source: EUROCAE WG114 / SAE G34 – SG3

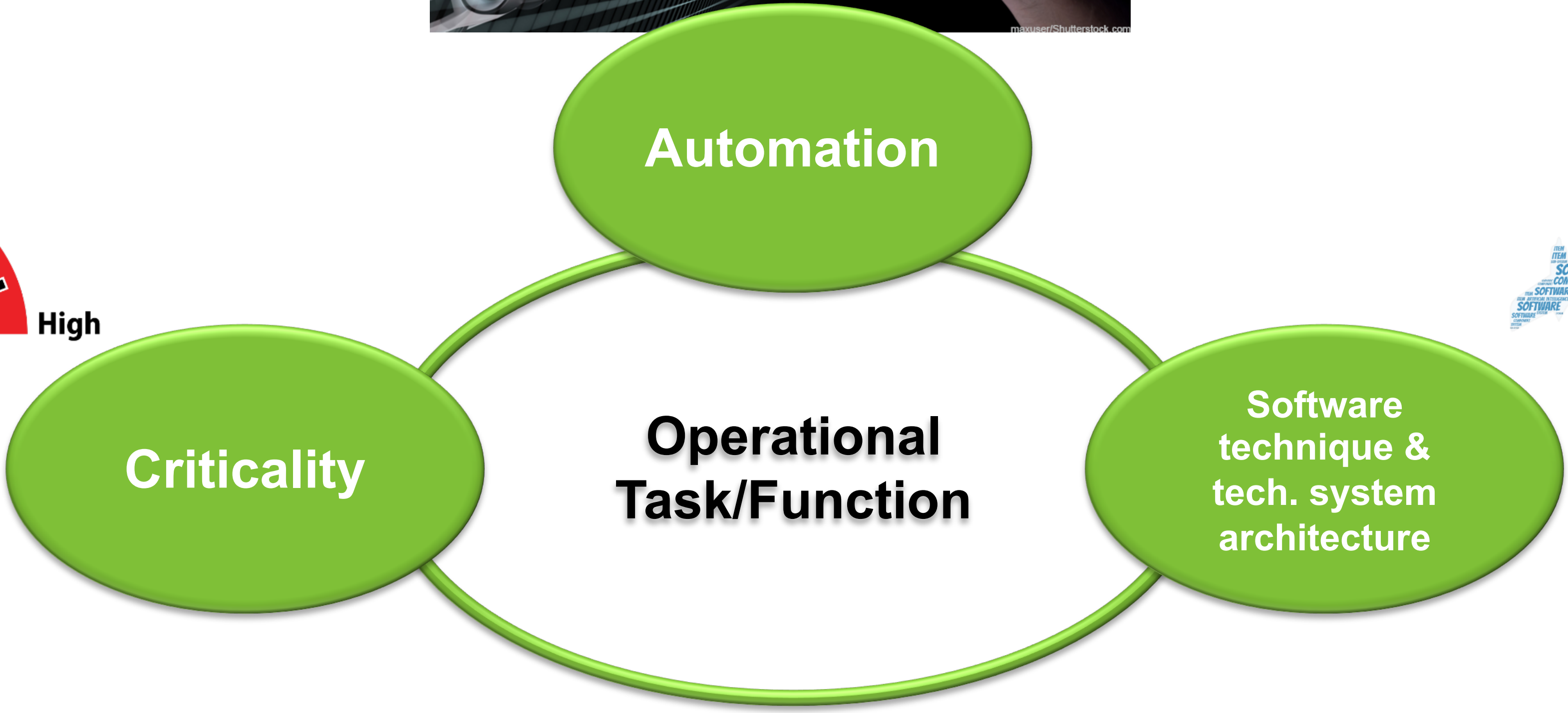
How to 'specify' and develop the ML items?

How to integrate them?

How to verify and validate the items?

How to verify and validate the subsystem?

How to specify the ML items …. To be safe ?



Provide optimised separation minimum, as per TBS rules, to each pair of aircraft in the final approach

Taxonomy for automation and cognitive processing

Source: Automation, Operator Functions and AI (A.Kilner)

The taxonomy is based on scientific papers presented by the FAA, SESAR and Industry

From the operator perspective

Automation

		Cognitive process			
		Information Acquisition	Information Analysis	Decision And Action Selection	Action Implementation
Increasing task support (LOA) [1]	0	A0 Manual Information Acquisition	B0 Working Memory Based Information Analysis	C0 Human Decision Making	D0 Manual Action and Control
	1	A1 Artefact-Supported information Acquisition	B1 Artefact-Supported Information Analysis	C1 Artefact-Supported Decision Making	D1 Artefact-Supported Action Implementation
	2	A2 Low-Level Automation Support of Information Acquisition	B2 Low-Level Automation Support of Information Analysis	C2 Automated Decision Support	D2 Step-by-step Action Support:
	3	A3 Medium-Level Automation Support of Information Acquisition	B3 Medium-Level Automation Support of Information Analysis	C3 Rigid Automated Decision Support	D3 Low-Level Support of Action Sequence Execution
	4	A4 High-Level Automation Support of Information Acquisition	B4 High-Level Automation Support of Information Analysis	C4 Low-Level Automatic Decision Making	D4 High-Level Support of Action Sequence Execution
	5	A5 Full Automation Support of Information Acquisition	B5 Full Automation Support of Information Analysis	C5 High-Level Automatic Decision Making	D5 Low-Level Automation of Action Sequence Execution
	6			C6 Full Automatic Decision Making	D6 Medium-Level Automation of Action Sequence Execution
	7				D7 High-Level Automation of Action Sequence Execution
	8				D8 Full Automation of Action Sequence Execution

[1] In fact Parasuraman [2] proposes 10 levels of automation however within Aviation, the first 9 are relevant to Systems where the operator remains present

TBS with (FTD) separation indicator

	Automated function:	Operator task:
Information acquisition		
AC/ position Type of A/C Weather (wind)	• Surveillance System + FLP information displayed on the screen • Weather information system	N/A
Information Analysis		
Identify pairs of A/C on the final approach	Done by an ATC equipment, not directly indicated to the operator	N/A
Decision and action selection		
Select the separation to be applied between pair of A/C	TBS tool calculating the TBS separation and displaying a chevron on the screen	Decision on the separation to be applied and selection of the instructions to be given to the pilot
Action Implementation		
Send instruction to pilot to apply separation	VHF	Controller sends the instructions to the pilot

LoA Task profile = A5 – B5 – C4 – D1

TBS (FTD)

		Cognitive process			
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	6			C6 Full Automatic Decision Making	D6 Medium-Level Automation of Action Sequence Execution
	7				D7 High-Level Automation of Action Sequence Execution
	8				D8 Full Automation of Action Sequence Execution

Using LOAT to design Automation

For each Level of Automation, a set of principle are to be taken in to account for the design of the Automated Function.

For example:

- **Design Principle : Awareness of system limitations**

In case the information acquisition function does not have the capability to present operationally relevant information items, the user should be made aware of this limitation with appropriate HMI design solutions

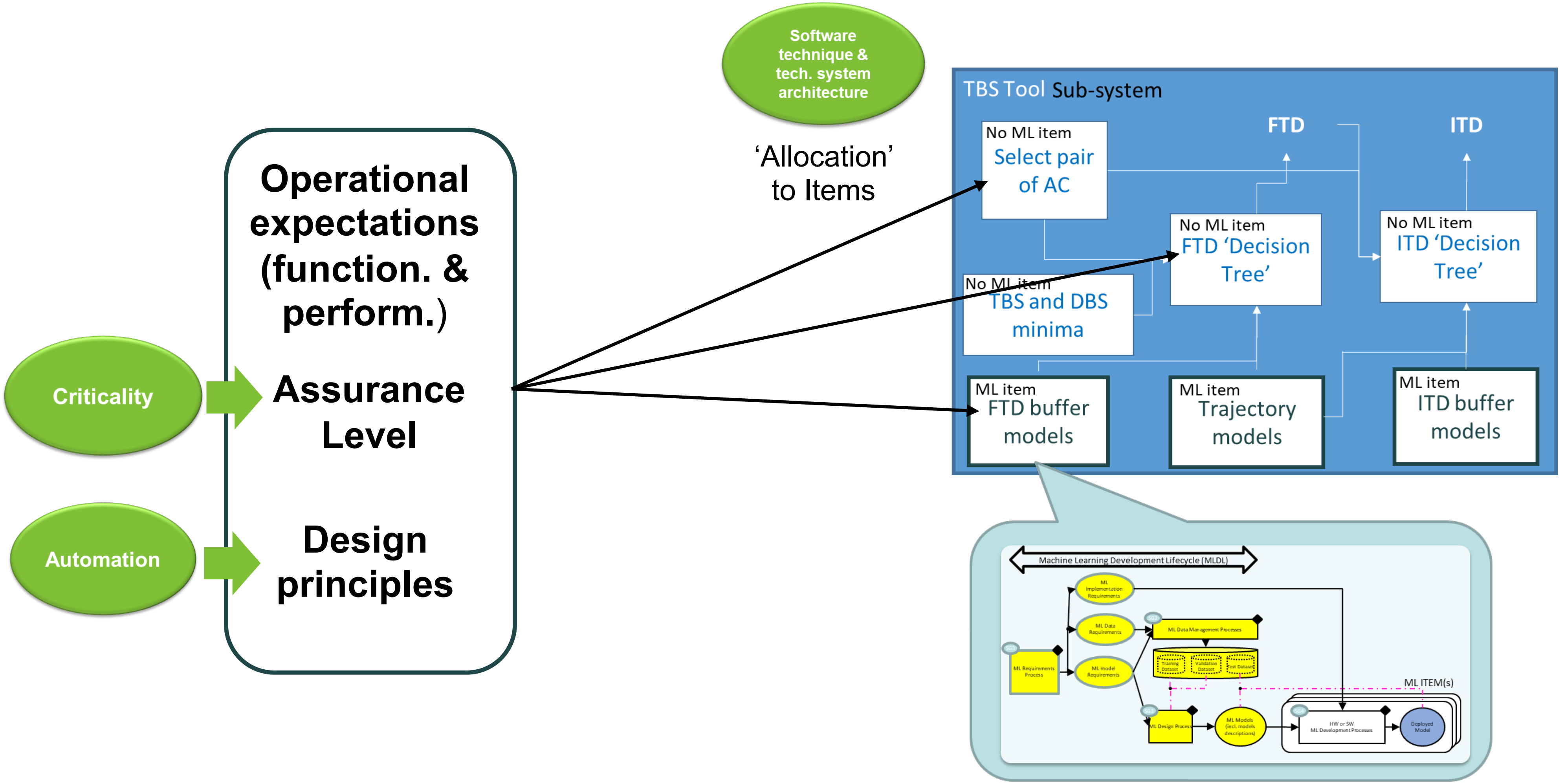
- **Design Principle : Suppression of Alerts**

If the decision support by automation can be overridden by the user, then define clear criteria or mechanisms for reactivation or reinsertion of the automation support.

- **Design Principle : Mode Error Prevention**

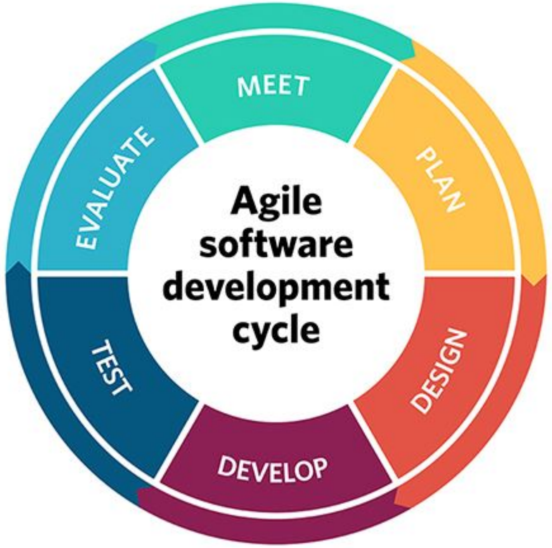
When an automated function can be configured to work according to different modes, it is essential that the user is always made aware of the active mode and timely informed of any mode change. To the extent possible the HMI design should contribute to minimize the risk of mode errors.

‘Specify’ the ML items



Stepping stones towards a safe AI in aviation

Safety integrated in the design process … from the beginning!



Step by step …

How to develop the ML items?

How to integrate the items?

How to verify and validate the ML items?

How to verify and validate the subsystem?

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Thank You

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