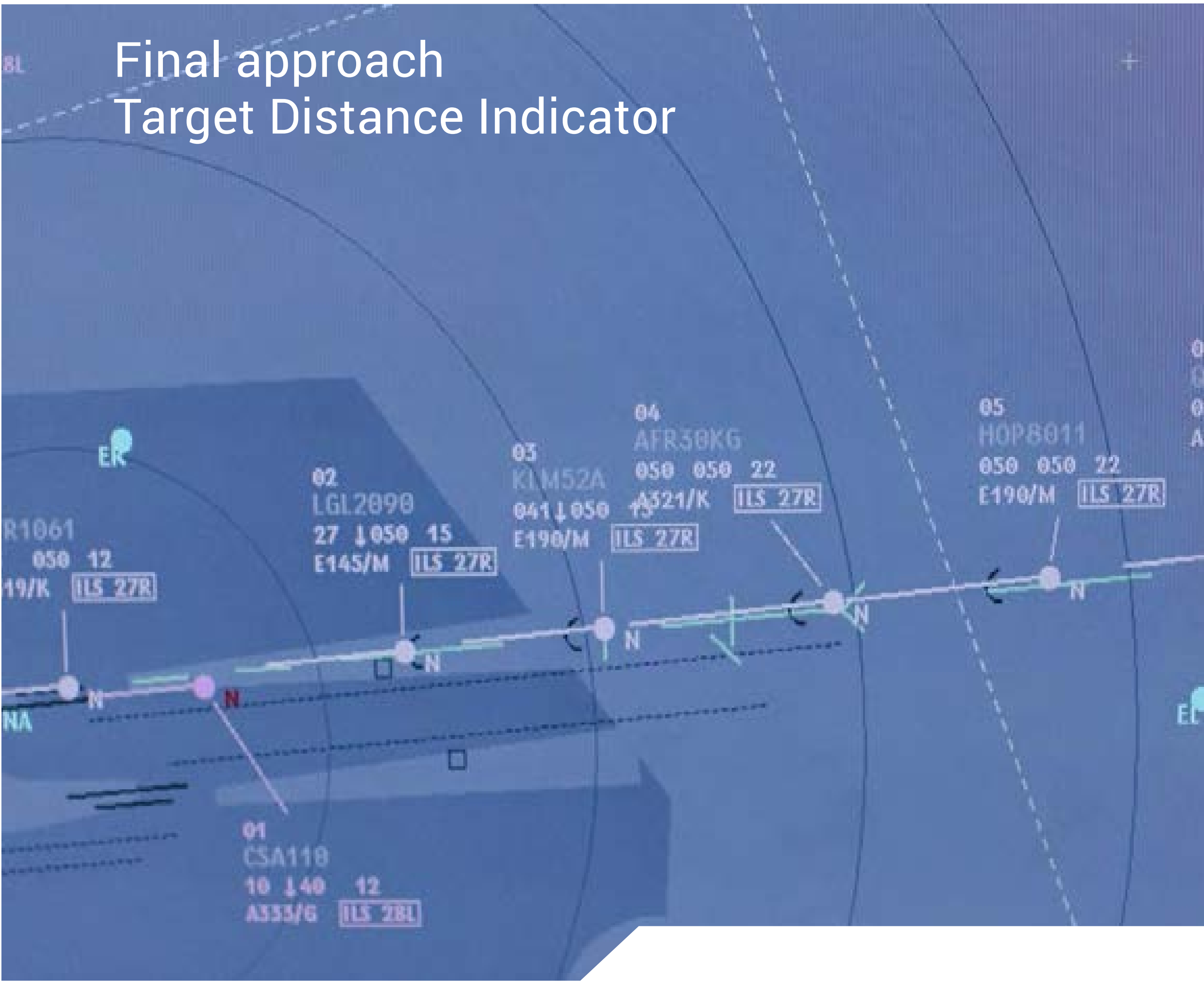
EUROCONTROL

‘FTDI’ Solution

Final approach
Target Distance Indicator



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"FTDI" Solution
Final Approach Target Distance Indicator

Edition Number:	1.0	**Edition Date:**	22/05/2023

Abstract

This document presents an operational solution for enhanced arrival runway throughput thanks to the use of the Final approach Target Distance Indicator (FTDi) supporting Air Traffic Controller in efficient traffic separation delivery, and also enabling application of most complex separation scheme.

The 'FTDi' solution is a by-product of the Time-Based Separation (TBS) on final approach, developed under the SESAR1 programme as Solution #64, however simplified as directly representing the distance-based separation minimum.

The FTDi displays the separation or spacing distance minimum on the final approach path to the Approach and Tower Traffic Controllers. It displays the largest separation or spacing constraints taking into consideration all applicable constraints, i.e., Surveillance / Radar, Wake Turbulence longitudinal or diagonal (under dependent parallel approaches) separation constraints, or spacing constraints such as Runway Occupancy Time, or gap under mixed mode runway operations.

This visualisation primarily offers safety enhancement as an aid to the ATCO for conforming to the separation minima.

The FTDi design will be integrated fully into the existing Controller Working Position. It requires a limited update of the Approach and Tower ATC system HMI, and can enable and facilitate the application of advanced separation schemes such as wake RECAT-EU or ROCAT (category-based), as well as their pair-wise version (RECAT-EU-PWS and iROT), further contributing to increase of the arrival runway throughput.

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STATUS, AUDIENCE AND ACCESSIBILITY

Status		Intended for		Accessible via	
Draft	☐	General Public	☐	Intranet	☐
Proposed Issue	☐	NM Stakeholders	☑	Extranet	☐
Released Issue	☑	Restricted Audience	☐	Internet (www.eurocontrol.int)	☑

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EXECUTIVE SUMMARY

The runway throughput in peak period is directly linked to the applicable minimum longitudinal separation applied between successive traffic on final approach or on departure. Those separation depends on the applicable separation and spacing minimum rules and the accuracy for the Approach and Tower Air Traffic Controllers (ATCOs) to deliver those minima.

The FTDi displays the separation or spacing distance minimum on the final approach path to the Approach and Tower Traffic Controllers to support them for safe and efficient delivery. It displays the largest separation or spacing constraints taking into consideration all applicable constraints, i.e., Surveillance / Radar, Wake Turbulence longitudinal or diagonal (under dependent parallel approaches) separation constraints, or spacing constraints such as Runway Occupancy Time, or gap under mixed mode runway operations. The FTDi design will be integrated fully into the existing Controller Working Position.

This visualisation primarily offers safety enhancement as an aid to the ATCO for conforming to the separation minima. It requires a limited update of the Approach and Tower ATC system HMI, and can enable and facilitate the application of advanced separation schemes such as wake RECAT-EU or ROCAT (category-based), as well as their pair-wise version (RECAT-EU-PWS and iROT), further contributing to increase of the arrival runway throughput.

The 'FTDi' solution is a by-product of the Time-Based Separation (TBS) on final approach, developed under the SESAR1 programme as Solution #64, however simplified as directly representing the distance-based separation minimum.

1. Visual Final Target Distance Indicator (FTDi)

1.1. Concept

The Final Target Distance Indicator (FTDi) displays the separation or spacing distance minimum on the final approach path to the Approach and Tower Traffic Controllers.

This indicator / marker is an aid to visualise the correct application of separation / spacing delivery, reducing the risk of under-separation/spacing.

The indicator design, and in particular shape (chevrons, line, star, …) and colour, will be integrated fully into the existing Controller Working Position.

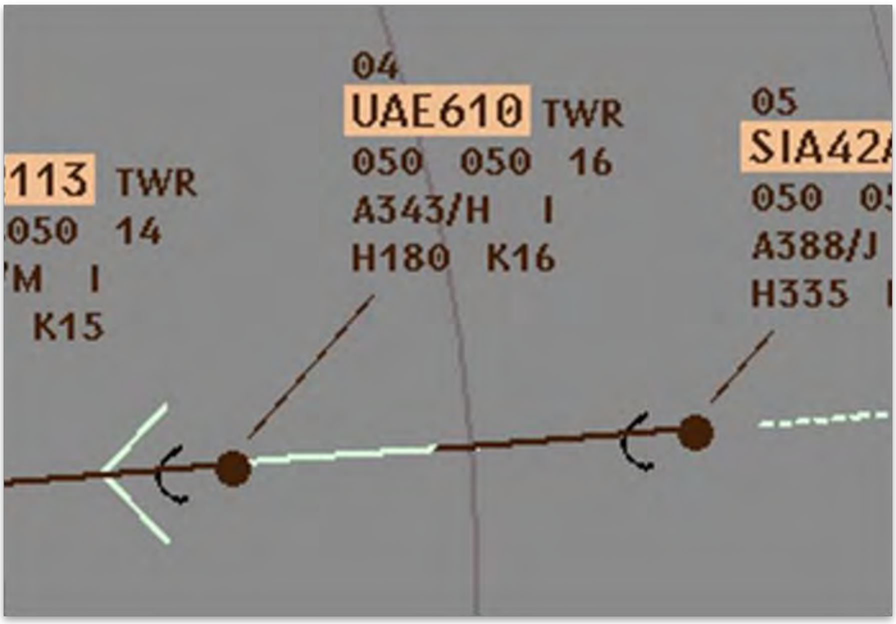


Figure 1: Illustration of FTDi

The FTDi takes into consideration all applicable separation and spacing constraints and displays the largest one.

Those separation and spacing minima between arrivals on final are dictated by:

- MSS/MRS - Minimum **Surveillance** / Radar Separation,
- WT - Minimum **Wake Turbulence** Separation, if applicable,
- ROT - **Runway Occupancy Time** spacing for
    - Segregated mode (A-A), or
    - Mixed mode on single or crossing runways (i.e., gap spacings for A-D-A).
- GAP
    - **Mixed mode** on single or **crossing** runways (i.e., gap spacings for A-D-A).
- **Diagonal** Separation for dependent simultaneous parallel approaches

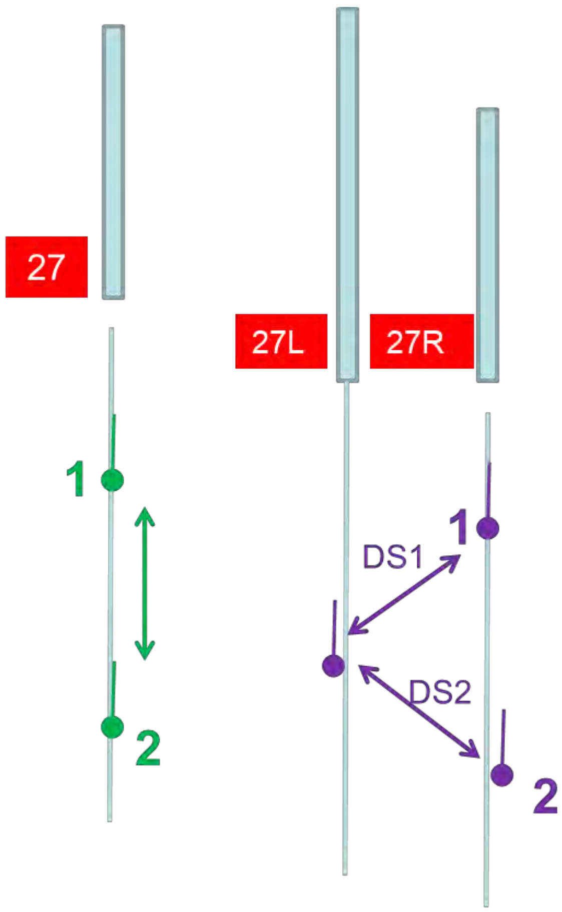


Figure 2: Illustration of in-trail segregated single / independent runway approach or dependent simultaneous approach separation

1.2. Benefits

The main benefits of FTDi are triple.

1. **Safety**

The use of FTDi improves the safety as the visualization of the applicable separation or spacing distance minimum on the Controller Working Position reduces the risk of under-separation/spacing.

2. **Operational Efficiency**

The use of FTDi improves overall the separation delivery accuracy, <u>also for mixed mode operations.</u>

3. **Enabler for advanced separation and spacing schemes increasing runway throughput**

FTDi also enables the application of advanced separation and spacing schemes. Those schemes can be with more categories like RECAT-EU 6-category wake turbulence scheme or ROCAT ROT-based category scheme. They can even be defined on a pair-wise basis such as static pairwise wake separation (PWS) scheme or individualised ROT spacing (iROT).

The 'FTDi' solution is a by-product of the Time-Based Separation (TBS) on final approach, developed under the SESAR1 programme as Solution #64, however simplified as directly representing the distance-based separation minimum. It can thus also be seen as a first steps towards the deployment of a Time-Based Separation (TBS) tool.

2. Use cases

FTDi can be used to support various use cases at the same time or separately. Various levels of complexity of those use cases can be covered.

2.1. Standard separation / spacing schemes

2.1.1. Surveillance separation (longitudinal and diagonal)

Surveillance minima are defined and agreed with the local regulator as a function of the surveillance system performance, local procedures and potential impact on runway spacing. This is a minimum distance separation to respect by all aircraft pairs going from 2.5 to more than 5.0 NM.

The applicable Minimum Radar Separation (MRS) rules shall be provided to the FTDi tool.

2.1.2. Wake Turbulence separation

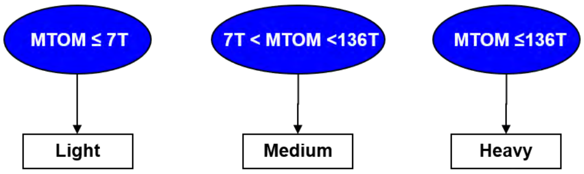
The FTDi tool requires as input the applicable Wake Turbulence distance-based separation scheme. Several options are possible.

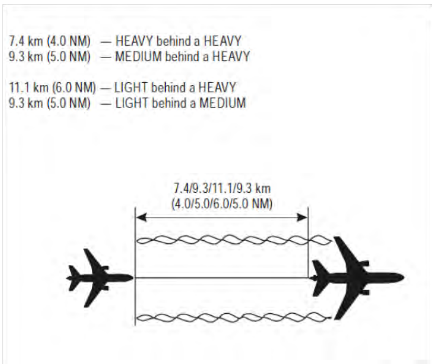
2.1.2.1. Current local separation scheme

Nowadays, most airports operate ICAO legacy wake turbulence category scheme. Some are operating another local scheme approved by local authority.

ICAO defines aircraft wake turbulence categories based on maximum take-off weights and provisions for longitudinal distance separation minima applicable for approach under ATS surveillance service (Document 4444 PANS-ATM).

Aircraft category		
Preceding aircraft	*Succeeding aircraft*	*Distance-based wake turbulence separation minima*
SUPER	HEAVY	9.3 km (5.0 NM)
	MEDIUM	13.0 km (7.0 NM)
	LIGHT	14.9 km (8.0 NM
HEAVY	HEAVY	7.4 km (4.0 NM)
	MEDIUM	9.3 km (5.0 NM)
	LIGHT	11.1 km (6.0 NM)
MEDIUM	LIGHT	9.3 km (5.0 NM)





2.1.2.2. RECAT-EU

Because the FTDi tool directly provides the applicable separation minima to the controller, integrating a more optimized wake separation scheme is straightforward with FTDi.

RECAT-EU optimises the wake turbulence separation minima on approach and departure by splitting the HEAVY category and the MEDIUM category.

RECAT-EU can bring up to +10% Capacity gain in runway throughput during peak periods depending on local airport traffic mix. It also improves resilience through faster recovery from adverse conditions, helping to reduce delays and improves flexibility for sequencing and managing the traffic.

	SUPER HEAVY	UPPER HEAVY	LOWER HEAVY	UPPER MEDIUM	LOWER MEDIUM	LIGHT
SUPER HEAVY (AN-124, A380)	3.0	4.0	5.0	5.0	6.0	8.0
UPPER HEAVY (A332, B744)		3.0	4.0	4.0	5.0	7.0
LOWER HEAVY (MD11, B763)		MRS*	3.0	3.0	4.0	6.0
UPPER MEDIUM (B738, A320)						5.0
LOWER MEDIUM (E190, AT45)						4.0
LIGHT (SF34, LJ35)						3.0

Table 1: RECAT-EU wake separation minima

It is approved by EASA and published as AMC to EU 2017/373 Part ATS.

RECAT-EU can be deployed

- as a **full solution**
- as a **partial solution** (e.g., for some types or combined with ICAO wake turbulence scheme leading to a 7-CAT scheme)

RECAT-EU		A	B	C	D	E	F	
	ICAO legacy	A388	Heavies		Medium			Light
A	A388		4	5	5	6	7	8
B	H		3	4	4	5	5	6
C	H			3	3	4	5	6
D	M							5
E	M							4
F	M							3
F	L							

Table 2: Example of combined ICAO-RECAT-EU 7CAT scheme

Full RECAT-EU solution is deployed at Paris, London Heathrow, Barcelona and Amsterdam. Partial RECAT-EU minima is deployed at Vienna, Leipzig, Koln-Bonn and Toulouse.

2.1.3. ROT spacing

The ROT constraint represents the amount of time that the leader aircraft occupies the runway (until vacating). The ROT is mainly driven by the runway (and runway direction) and its exit locations and by the aircraft types and their ability to brake.

The FTDi tool shall be fed with a safe (i.e. conservative) distance spacing value corresponding to this ROT.

2.1.3.1. Current ROT spacing rules

By default, Runway Occupancy Time (ROT) distance minima are usually agreed globally or per wake category based on operational experience. Those minima are often also mixed with surveillance minima.

2.1.3.2. ROCAT

Because the FTDi tool directly provides the applicable spacing minima to the controller, integrating a more optimized ROT spacing solution is straightforward with FTDi.

ROCAT defines two or more categories of traffic based on runway occupancy time (ROT). ROCAT allows reduced spacing minima on final approach behind the categories with the lower average ROT, whilst complying with surveillance minima and wake minima (when applicable).

- Example #1
  - 2.5 NM spacing minima behind a lower ROT Medium category aircraft
  - 3 NM minima for other Mediums
- Example #2
  - 3 NM spacing minima behind a category of aircraft with lower ROT
  - 4 NM minima for other types.

ROCAT can then bring runway throughput gain ranging from 5% to >10% during peak periods depending on the proportion of aircraft types in the category of low ROT value. It also improves resilience with faster recovery from adverse conditions, helping to reduce delays.

The definition of ROCAT ROT spacing minima and related category builds on ICAO PANS-ATM doc 4444 provisions.

2.1.4. GAP spacing (if relevant)

In case of mixed mode operations, the FTDi tool shall be provided with the appropriate distance spacing between two arrivals allowing the planned departure. This value shall be based on mixed mode scheme (e.g., A-D-A, A-D-D-A) and the arrival and departure runway occupancy times.

2.2. Advanced separation / spacing schemes

Because the FTDi tool directly provides the applicable separation and spacing minima to the controller, it is also an enabler to even more optimized separation and spacing solutions that would not be achievable without separation delivery tool.

2.2.1. Pair-wise Wake Separation (RECAT-EU-PWS)

RECAT-EU-PWS optimises wake turbulence separations on Approach and Departure by defining Pair-Wise Separation (PWS) minima and a 20-category scheme.

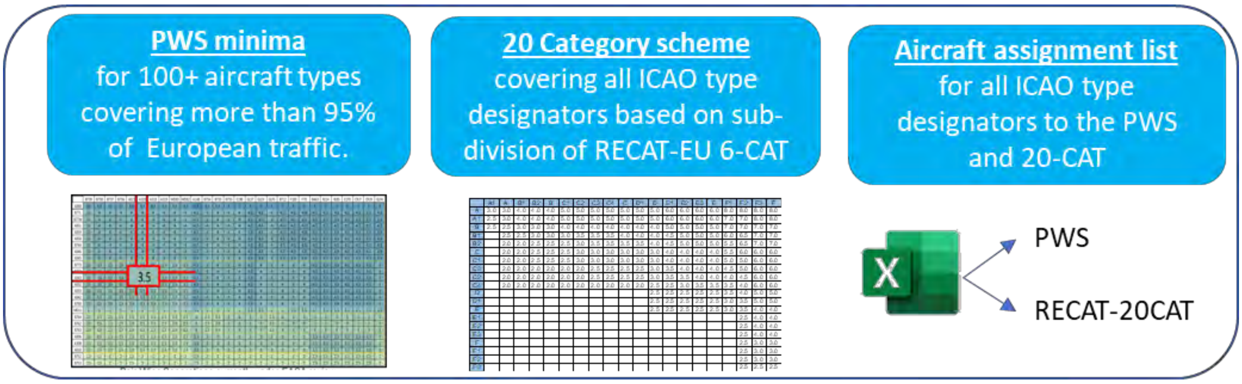


Figure 3: RECAT-EU-PWS package

RECAT-EU-PWS brings up to +13% gain in runway throughput during peak periods depending on individual airport traffic mix. It also improves resilience through faster recovery from adverse conditions, helping to reduce delays. Finally, it improves flexibility for sequencing and managing the traffic.

RECAT-EU-PWS safety Case has been developed by EUROCONTROL also through consultation process with stakeholders and is now under review by EASA.

2.2.2. Individual ROT spacing (iROT)

iROT optimises the ROT spacing by defining individual ROT distance spacing per leader aircraft type and landing runway. iROT minima are defined based on the average ROT characterization.

In case a separation delivery tool is used for approach, the iROT full solution can be deployed, hence delivering full benefits. For each leader flight, the tool will consider as ROT-spacing the iROT minimum. The tool will then display this spacing distance in the FTDi provided that no larger constraint is applicable (e.g., wake turbulence).

The benefits related to full iROT deployment lie in the fact that

- no rounding up of the minima to the upper 0.5 NM has to be performed (2.6 NM or 2.8 NM instead of 3NM can be applied)
- no alignment of the spacing on the largest ROT spacing of the category has to be applied (e.g., each member of the A320 family could have different ROT spacing minimum).

3. Implementation needs

3.1. Input

- Arrival sequence
- Landing runway
- Leader and follower aircraft types and categories
- Applicable separation and spacing constraints defined per type or category
    - Minimum surveillance separation
    - Wake Turbulence separation
    - ROT distance spacing
    - GAP for mixed mode (if any)
    - Diagonal separation (if any)
- Aircraft latitude/longitude position and altitude

3.2. Output

Visual marker displayed on the CWP, attached to the leader aircraft type at a distance corresponding to the largest applicable separation or spacing minima to be delivered on final approach.

4. Deployment considerations

FTDi is already operational, for example in Prague (LKPR) and Barcelona (LEBL) Approach ATS Unit. Advanced versions allowing TBS and with 'compression indicator' for Optimized Runway Delivery (ORD) are deployed in London Heathrow (EGLL) and Amsterdam Schiphol (EHAM) Approach.

The following elements should be considered when deploying an FTDi solution.

1. Ensuring all use cases with corresponding **applicable separation and spacing constraints have been defined** and in particular
    - Wake turbulence separation minima
    - Surveillance minima
    - ROT spacing
    - Gap spacing for mixed mode operations
    - Diagonal separations
2. Ensure correct aircraft type data are filed into flight plans
3. Ensuring Air Traffic Controllers appropriate training
    - on ATC automation support and separation delivery tool
    - On ATC operation without support tool in case of tool failure
4. Ensuring safety and in FTDi monitoring in operations
5. Maintenance of FTDi tool inputs if needed

ABBREVIATIONS

ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Flow Management
ATS	Air Traffic Services
CAT	Category
EASA	European Aviation Safety Agency
EUROCONTROL	European Organisation for the Safety of Air Navigation
FTDi	Final Target Distance Indicator
ICAO	International Civil Aviation Organisation
iROT	Individual Runway Occupancy Time
MRS	Minimum Radar Separation
MSS	Minimum Surveillance Separation
NM	Nautical Mile
NMD	EUROCONTROL Network Management Directorate
ORD	Optimum Runway Delivery
PWS	Pair-Wise Separation
R&D	Research and Development
RECAT	Re-categorisation
ROCAT	Re-categorisation based on ROT
ROT	Runway Occupancy Time
TBS	Time-Based Separation
WT	Wake Turbulence

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