

AN ASSESSMENT ON THE SAFETY AND COMPLEXITY OF THE INNOVATIVE DESIGN OF ISTANBUL'S NEW TMA

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LTFM Airspace Design

❑ Filling a blank page and defining a new airspace all over again by making radical changes

❑ Istanbul Airport (LTFM) has inherited the aviation code “IST” from Atatürk Airport (LTBA) - opened in 1953 and ranked seventeenth worldwide in terms of passenger traffic in 2018 by Airports Council International on 6 April 2019





Conceptual Framework

- ❑ To make a comparative analysis of the new and old Istanbul Terminal Manoeuvring Area (TMA) designs according to the evolution of traffic safety and complexity issues

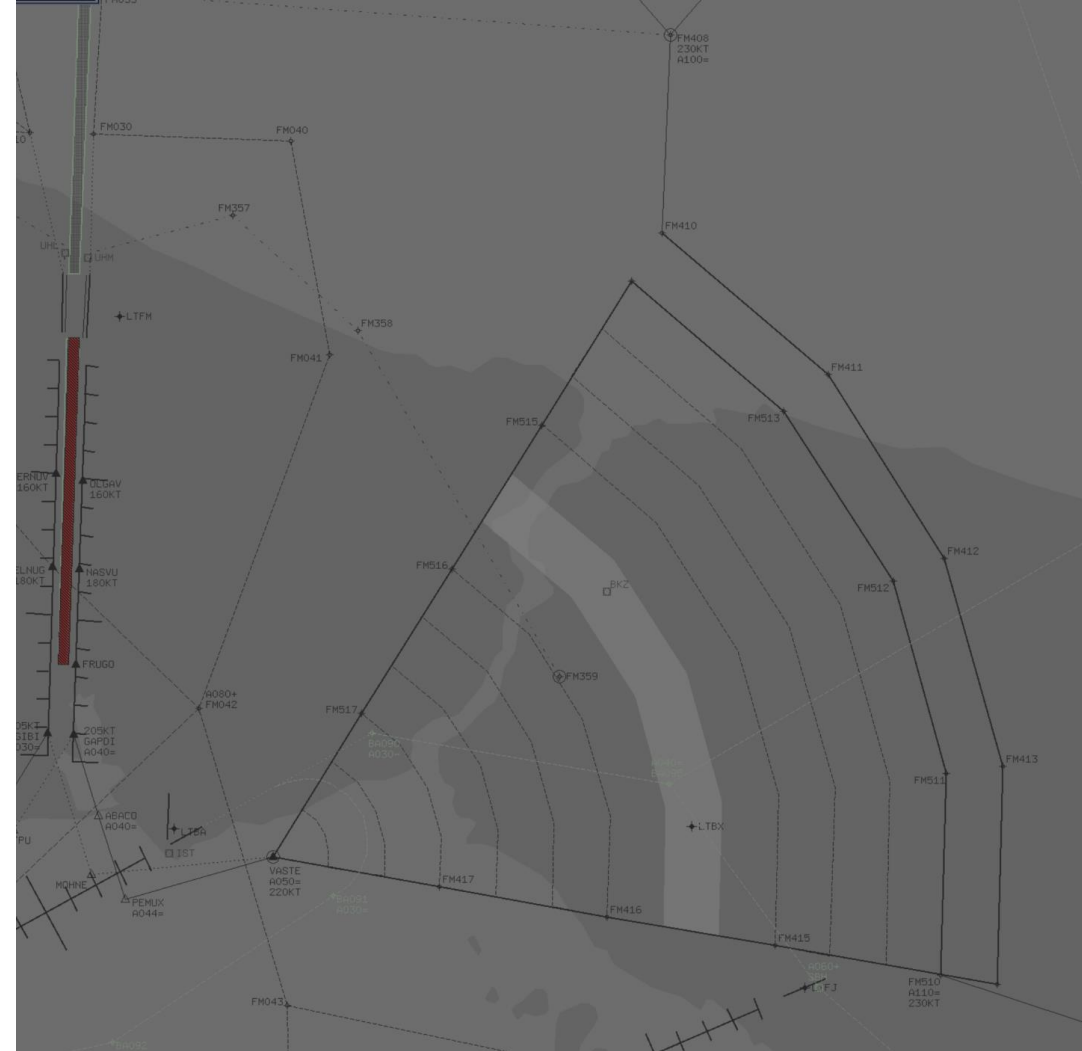


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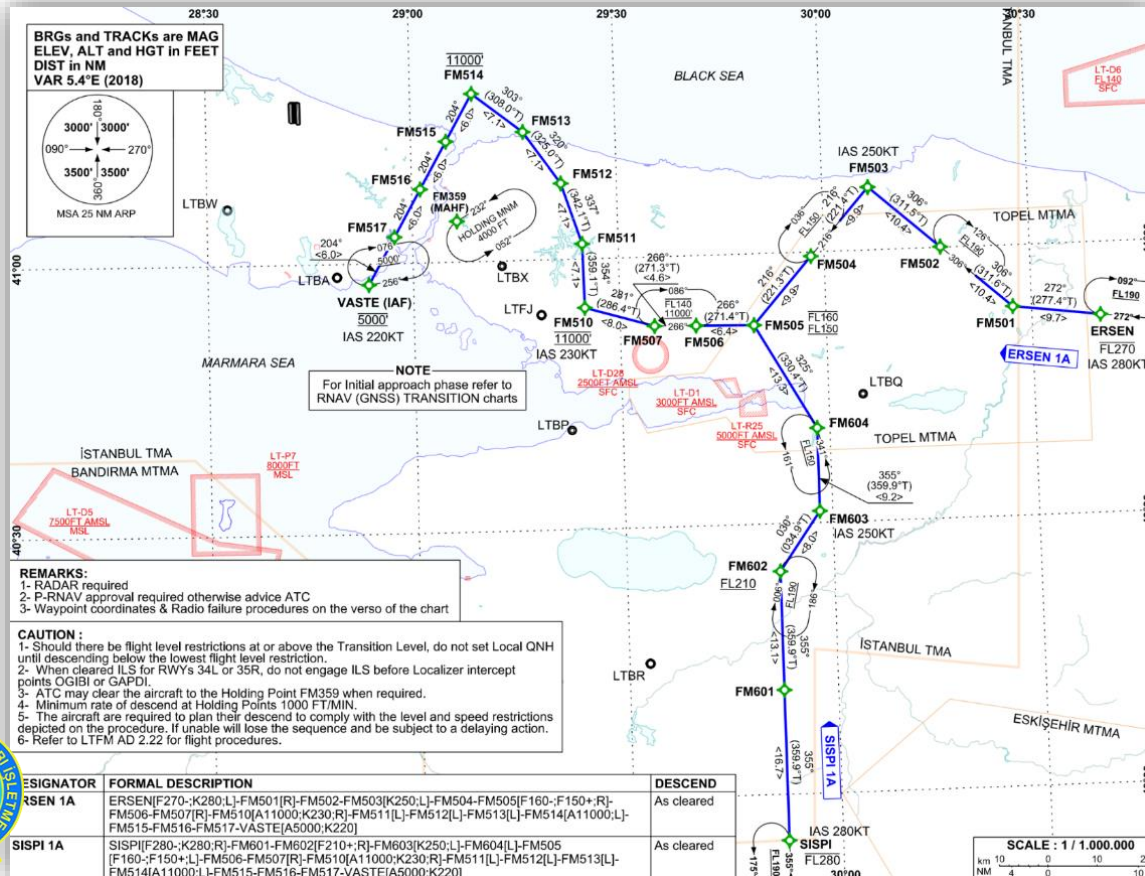
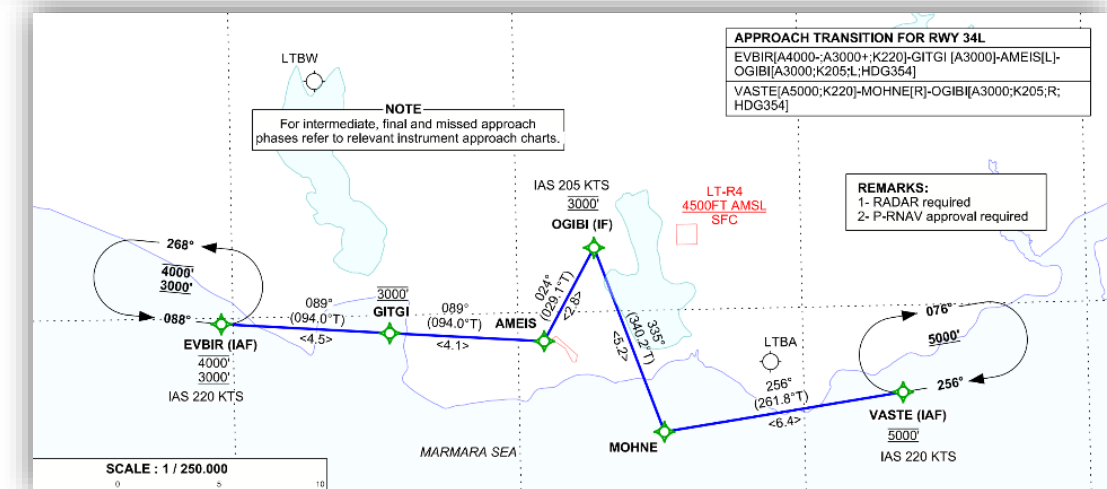
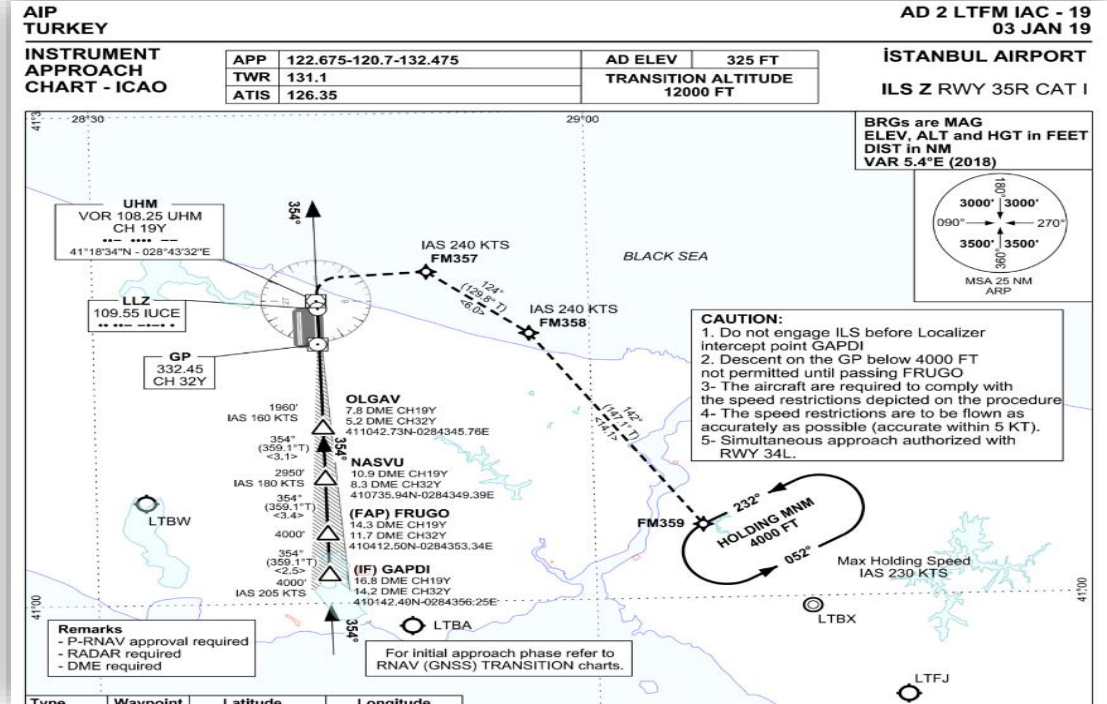
Point Merge System

- ❑ Developed at EEC in 2006
- ❑ Predictability
- ❑ Create and maintain spacing
- ❑ Continuous Descent Operations (CDO)
- ❑ Continuous Climb Operations (CCO)
- ❑ Situational Awareness
- ❑ R/F Occupancy & workload reduced



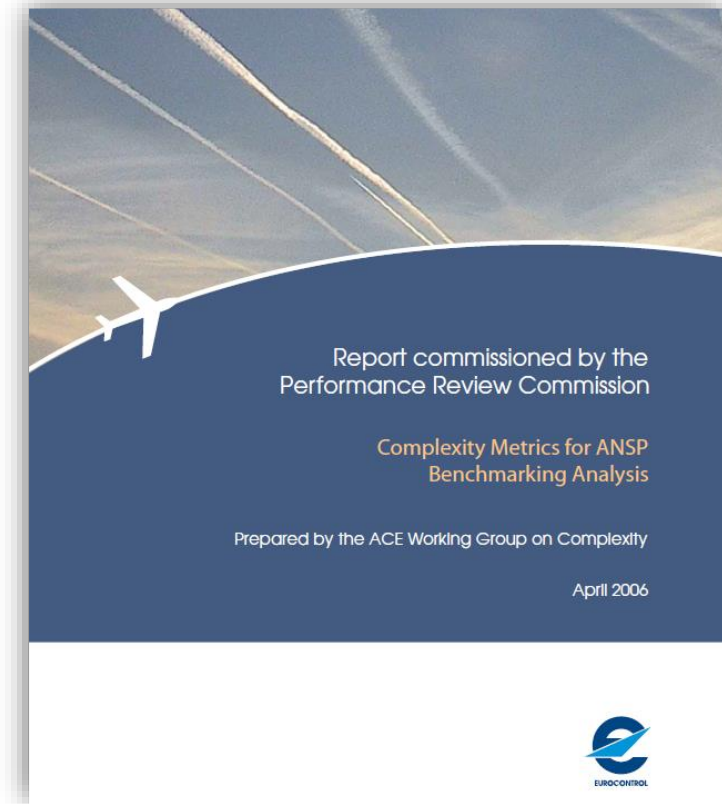
Point Merge System

Transition procedure & LNAV in LTFM



Complexity Indicators

- ❑ «Complexity Metrics for ANSP Benchmarking Analysis” for the Performance Review Commission by the ACE Working Group on Complexity, 2006
 - ❑ Function of complexity
 - ❑ Based on the adjusted density and structural index
- ❑ Davis, Danaher and Fischl (1963)
- ❑ Stein (1985)
- ❑ Meckiff et al (1998)



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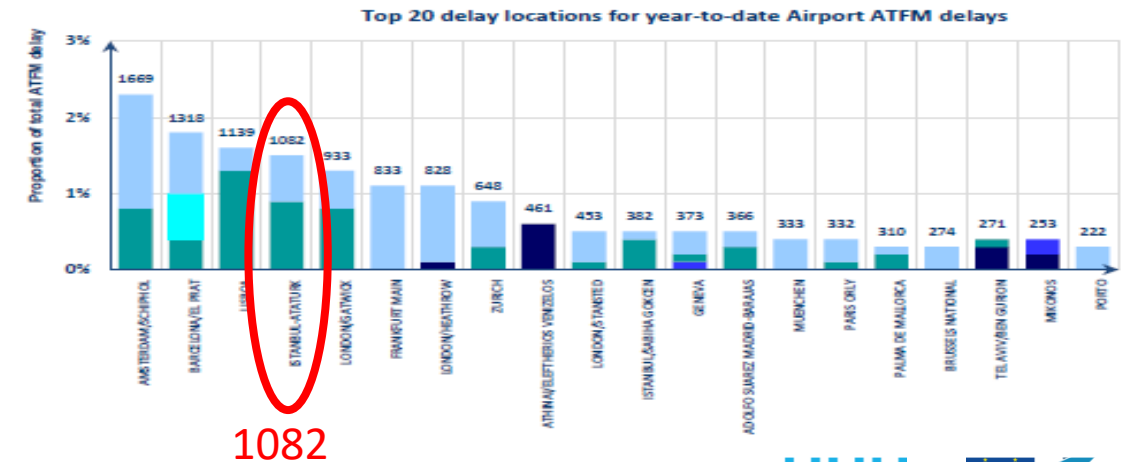
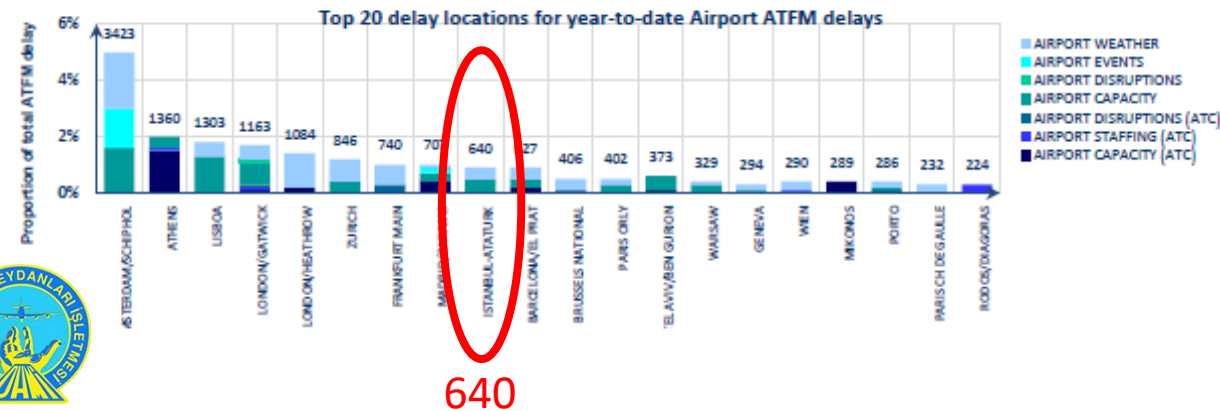


LTFM TMA Deployment and Process

N°	ADEP	ADEP NAME	201907	%
1	EDDF	FRANKFURT MAIN	760	1.1%
2	LFPG	PARIS CH DE GAULLE	758	3.3%
3	EHAM	AMSTERDAM/SCHIPHOL	740	-1.7%
4	EGLL	LONDON/HEATHROW	681	0.8%
5	LTFM	ISTANBUL NEW AIRPORT	634	0.0%
6	LEMD	ADOLFO SUAREZ MADRID-BARAJA	629	5.1%
7	EDDM	MUENCHEN	607	1.8%
8	LEBL	BARCELONA/EL PRAT	536	1.9%
9	LIRF	ROMA/FIUMICINO	493	-0.1%
10	LTAI	ANTALYA	468	7.9%

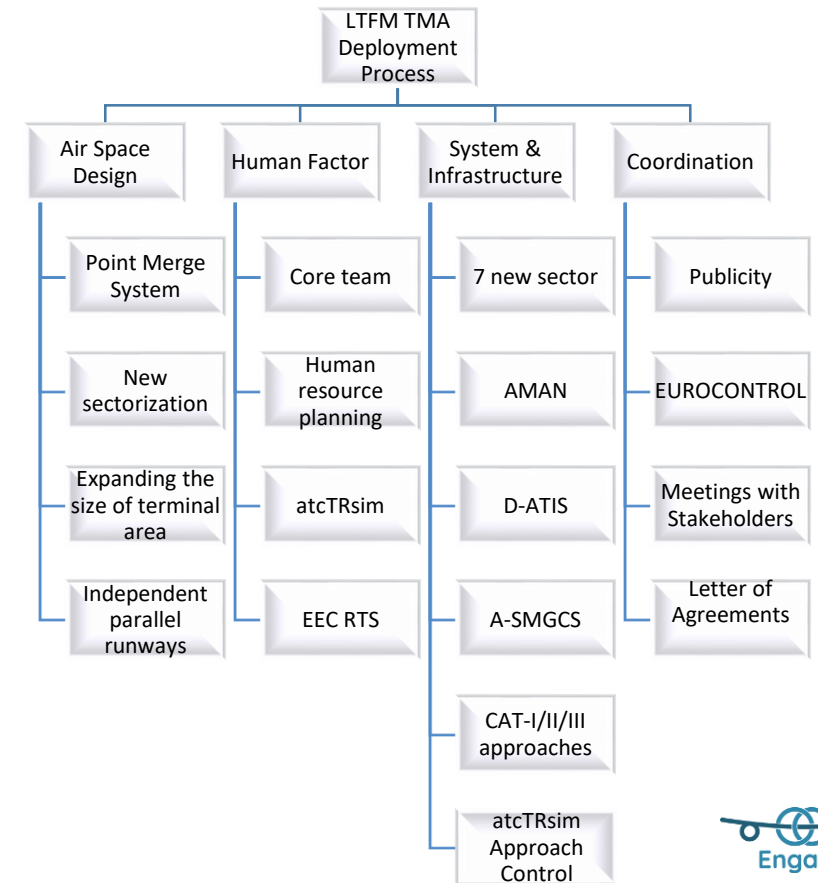
N°	ADEP	ADEP NAME	201907	%
1	EHAM	AMSTERDAM/SCHIPHOL	753	-1.8%
2	EDDF	FRANKFURT MAIN	752	1.3%
3	LFPG	PARIS CH DE GAULLE	733	2.9%
4	EGLL	LONDON/HEATHROW	677	0.1%
5	LTFM	ISTANBUL ATATURK	670	-1.7%
6	LEMD	ADOLFO SUAREZ MADRID-BARAJA	598	5.7%
7	EDDM	MUENCHEN	596	1.4%
8	LEBL	BARCELONA/EL PRAT	526	1.5%
9	LIRF	ROMA/FIUMICINO	483	2.9%
10	LEPA	PALMA DE MALLORCA	481	2.9%

AIRPORT/TMA ATFM DELAY YEAR-TO-DATE



LTFM TMA Deployment and Process

- ❑ Well-re-organized air space design without compromising the safety of air traffic management and aviation
- ❑ Human factors to create the innovative and collaborative environment enabling the learning organization in this team
- ❑ New systems and infrastructure for providing the interoperability
- ❑ Well-organized and inclusive coordination with all stakeholders



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Methodology

- ❑ The following hypotheses are tested; by reorganizing the Istanbul's new TMA all over again
 - ❑ The adjusted density of the TMA has been decreased.
 - ❑ The PRU complexity of the TMA has been decreased.
 - ❑ The conflict number per aircraft has been decreased.



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Methodology

TOOL

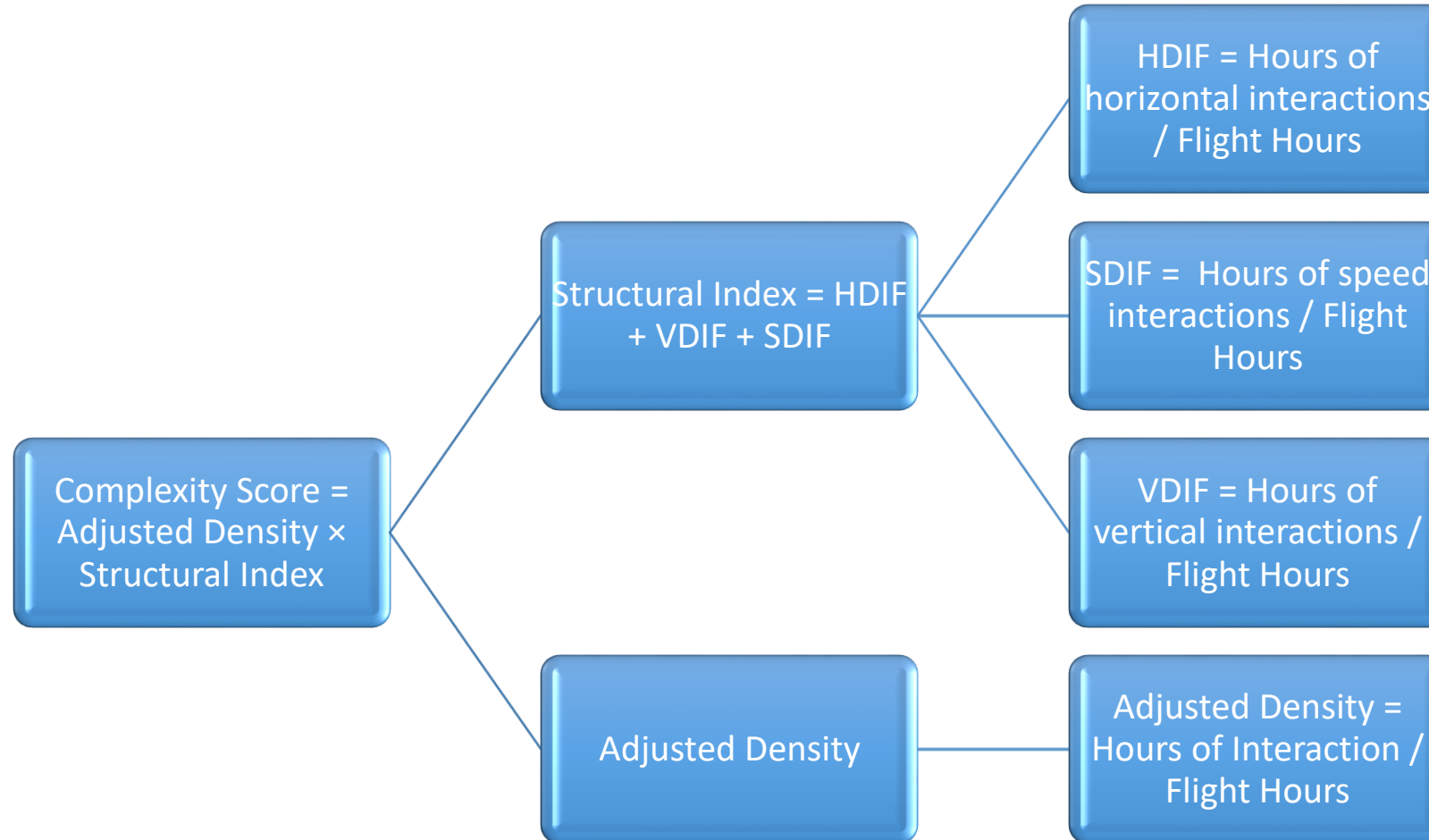
The actual and initial traffic from Demand Data Repository (DDR2) from Eurocontrol

- We obtain indicators on safety and complexity using the Network Strategy Tool (NEST)

DATA COLLECTION

	LTBA	LTFM
Thursday	14.06.2018	13.06.2019
Friday	15.06.2018	14.06.2019
Saturday	16.06.2018	15.06.2019
Monday	09.07.2018	08.07.2019
Tuesday	10.07.2018	09.07.2019
Wednesday	11.07.2018	10.07.2019

Methodology

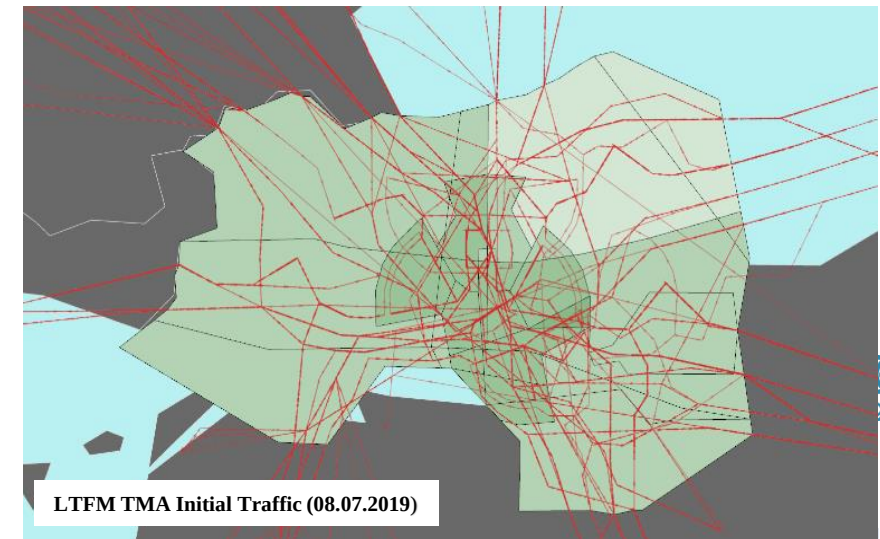
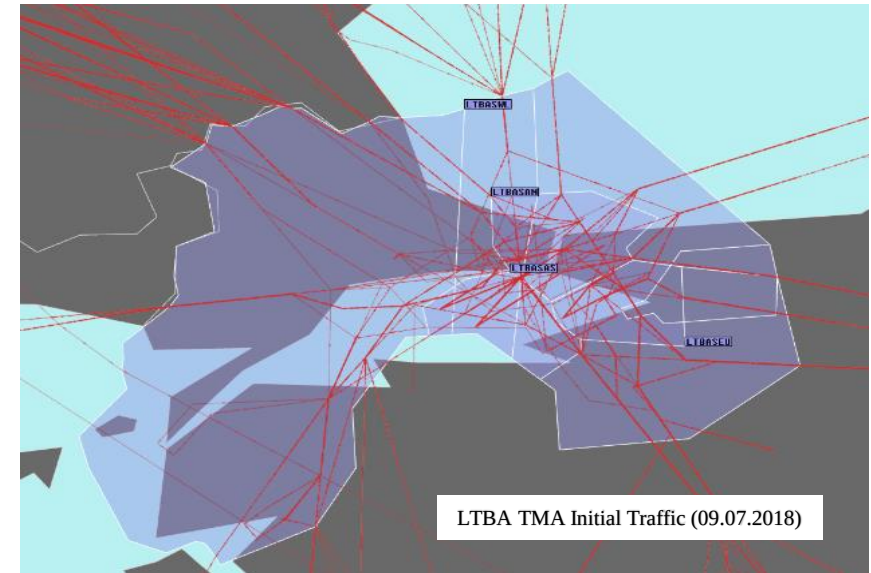


Methodology

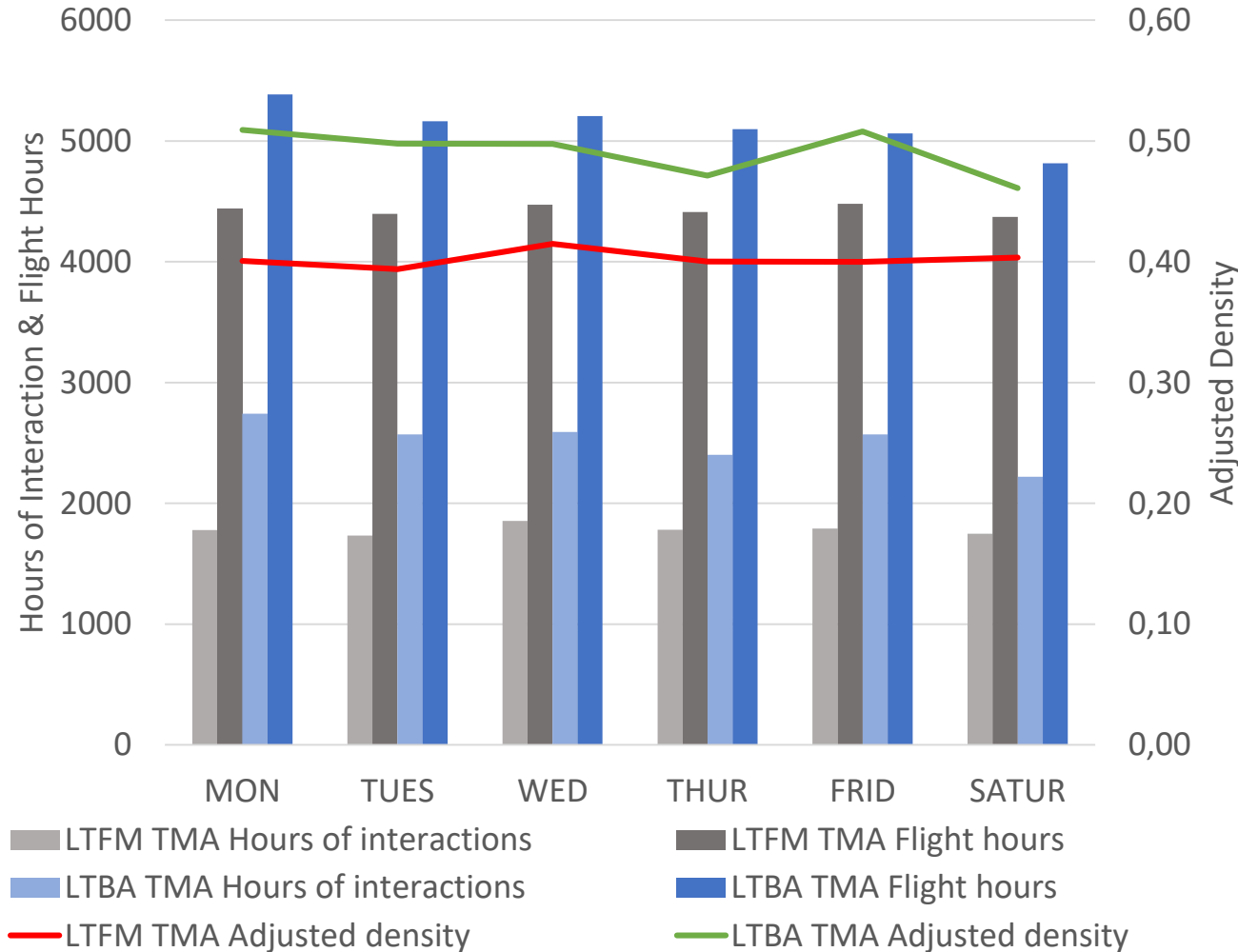
- ❑ **The hours of interactions** are the sum of all durations of all the interactions including vertical, horizontal and speed, in all cells between FL85 and FL245.
- ❑ The sum of the flight durations controlled in all cells in a defined area over a period is called **flight hours**. The 3D dimensions of cells are 20 NM x 20 NM x 3000 FT and flight time in these cells averaged during discrete 60-minute periods represents “flight hour”
- ❑ **Conflict**, defined as a pair of flights being detected a loss of vertical or horizontal separation by NEST, is calculated daily with calculations steps of 10 seconds, taking into account average delays of 120 seconds with standard deviation of 120 seconds and 3 NM horizontal separation within the defined Istanbul TMA.

Results

LTBA	14.06.2018	15.06.2018	16.06.2018	9.07.2018	10.07.2018	11.07.2018
Hours of interactions	2401	2570	2220	2742	2570	2591
Flight hours	5097	5061	4816	5386	5164	5207
Number of Traffic (Initial)	2172	2093	2033	2210	2125	2146
LTFM	13.06.2019	14.06.2019	15.06.2019	8.07.2019	9.07.2019	10.07.2019
Hours of interactions	1780	1792	1749	1777	1732	1855
Flight hours	4411	4480	4372	4436	4396	4471
Number of Traffic (Initial)	2141	2174	2110	2137	2120	2152

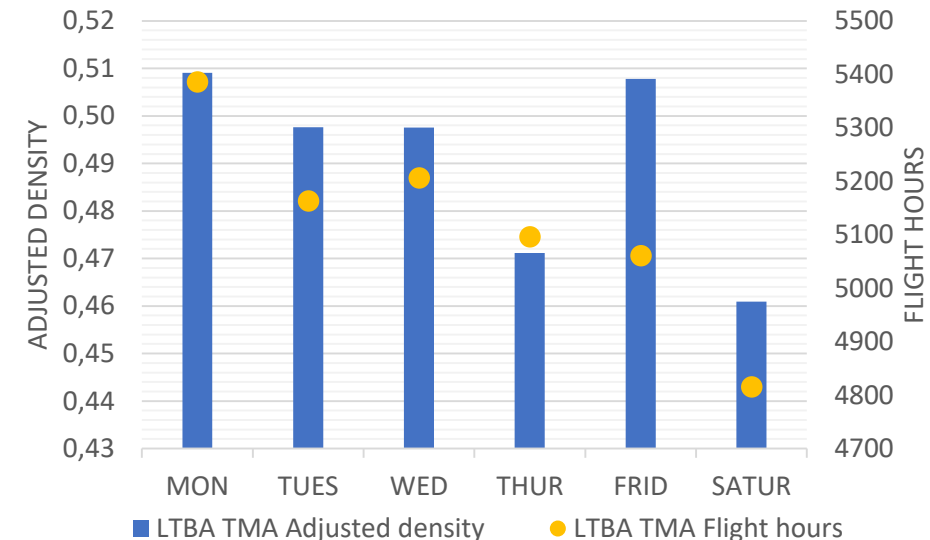
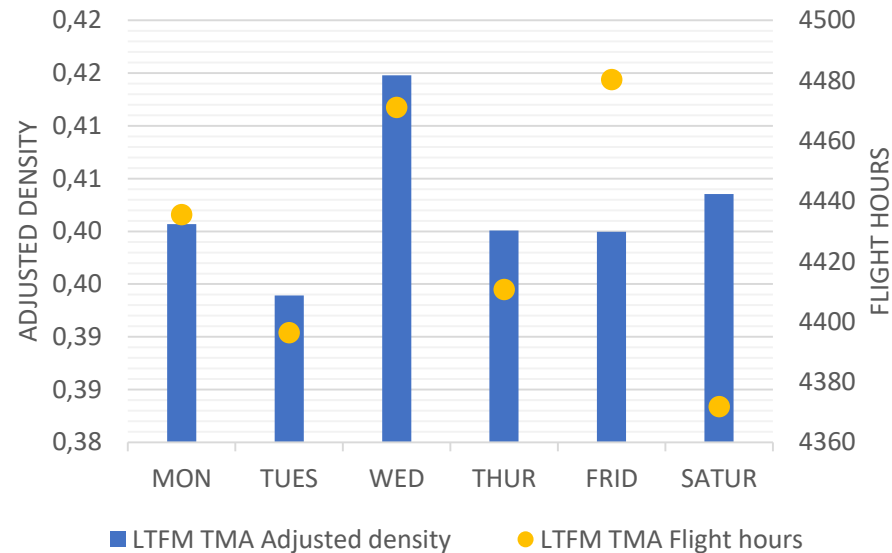


Results



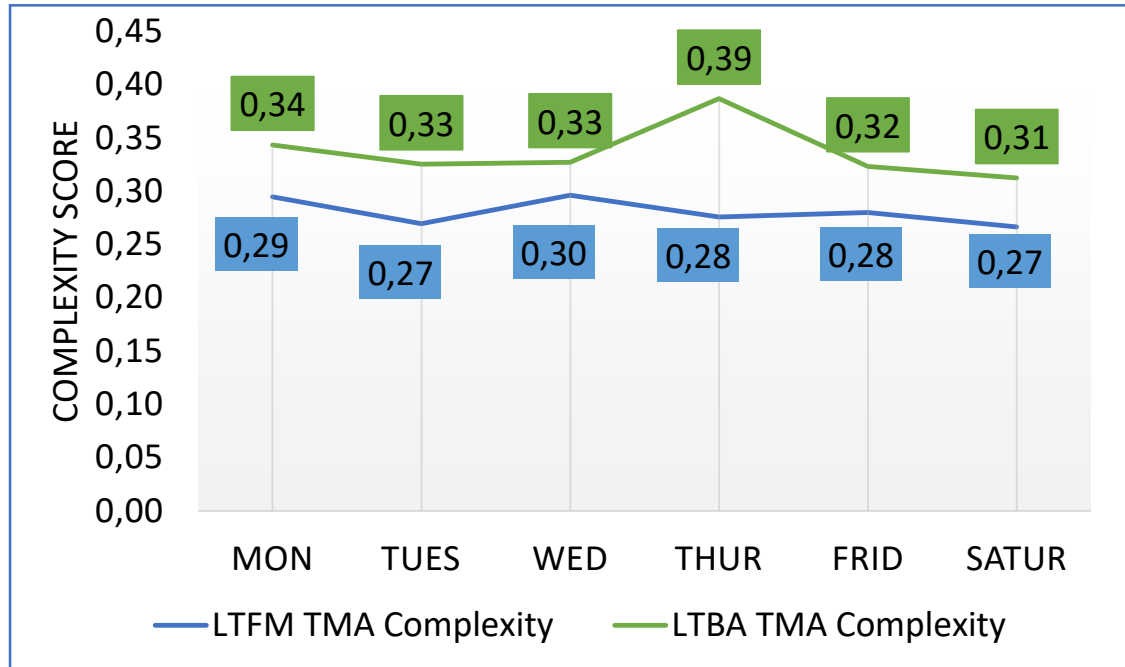
- ❑ The new TMA design for LTFM has decreased the density of traffic on selected dates.
- ❑ The average of the difference of density between LTBA and LTFM TMA is **17.9%** for the selected dates.

Results



- ☐ Pearson's correlation coefficient between adjusted density and flight hours in LTBA TMA is found as **0.76** while the same correlation in LTFM TMA (**0.52**) is not as high as in LTBA
- ☐ The new design breaks the strong positive relationship between the traffic level expressed in flight hours and the density of the traffic.

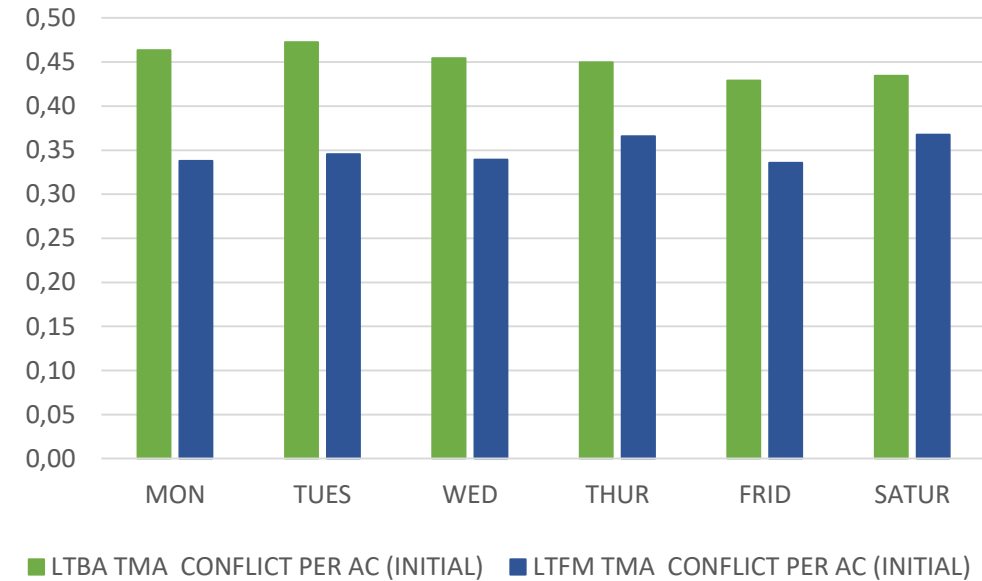
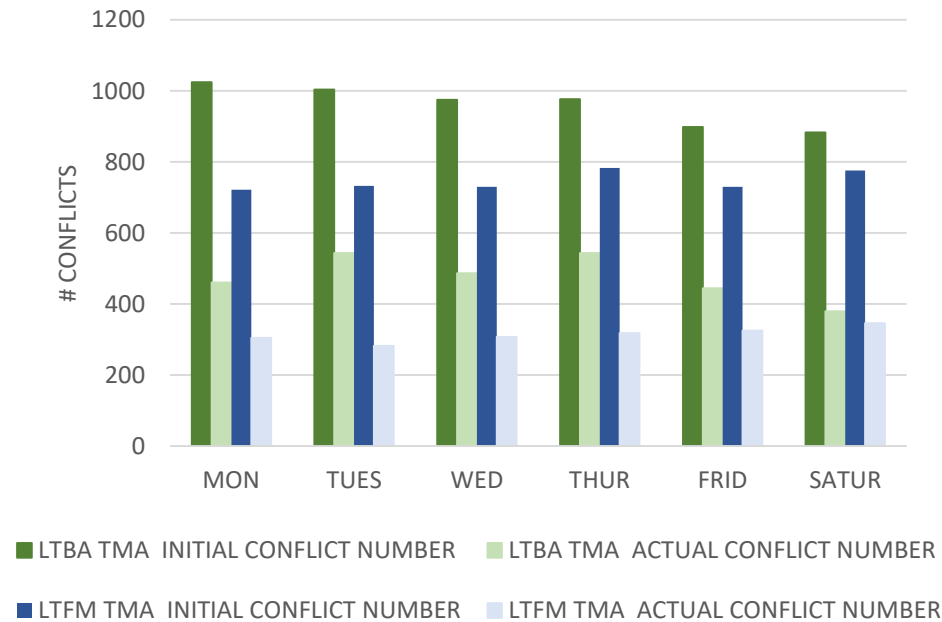
Results



Correlation	Structural Index	Flight Hours	Adjusted Density
LTFM TMA Complexity	0.93	0.74	0.67
LTBA TMA Complexity	0.91	0.30	-0.19

- ❑ The PRU complexity score of LTFM TMA is **0.28**, on average
- ❑ The PRU complexity score of LTBA TMA is **0.34**, on average
- ❑ Overall **20%** decrease in the complexity

Results



- ❑ **51 %** of the conflict numbers based on FTFM is captured by the conflicts based on CTFM in LTBA TMA, whereas this ratio is **58 %** in LTFM TMA
- ❑ The conflict number per aircraft has decreased to **0.35** in LTFM TMA while this number is calculated as **0.45** in LTBA TMA

Results

LTBA TMA	DATE	14.06.2018	15.06.2018	16.06.2018	9.07.2018	10.07.2018	11.07.2018
	# TRAFFIC (INITIAL)	2172	2093	2033	2210	2125	2146
	CONFLICT PER AC (INITIAL)	0.45	0.43	0.43	0.46	0.47	0.45
	COMPLEXITY	0.39	0.32	0.31	0.34	0.33	0.33
LTFM TMA	DATE	13.06.2019	14.06.2019	15.06.2019	8.07.2019	9.07.2019	10.07.2019
	# TRAFFIC (INITIAL)	2141	2174	2110	2137	2120	2152
	CONFLICT PER AC (INITIAL)	0.37	0.34	0.37	0.34	0.35	0.34
	COMPLEXITY	0.28	0.28	0.27	0.29	0.27	0.30



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Conclusion

- ❑ High level objective; fulfilling our responsibility with a high quality service while maintaining safety level
- ❑ The drastic and reformative changes in Istanbul's new TMA (LTFM TMA) are introduced and the overall benefit is presented with a snapshot of the safety and complexity, comparing to the LTBA TMA.

Conclusion

- ❑ The hours of interactions and flight hours have decreased in LTFM TMA though the traffic numbers have increased
- ❑ The complexity of LTFM TMA has decreased (**0.28** on average) compared to LTBA TMA (**33.5** on average)
- ❑ Conflict number per aircraft reducing from **0.45** in LTBA to **0.35** in LTFM
- ❑ The adjusted density of LTFM TMA has decreased considerably



The correlation results and safety statistics show that implementing the point merge system successfully and the efficient redesign of LTFM terminal airspace with radical and innovative changes have increased the predictability and consistency of one of the most fast-growing and busiest terminal areas.



Thank you and Questions



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