



AN ANALYSIS OF TBFM

RAHAT MAINI

mentored by:

ROBERT WINDHORST

PALLAVI HEGDE

ABOUT ME

Engineering

Design

Movies



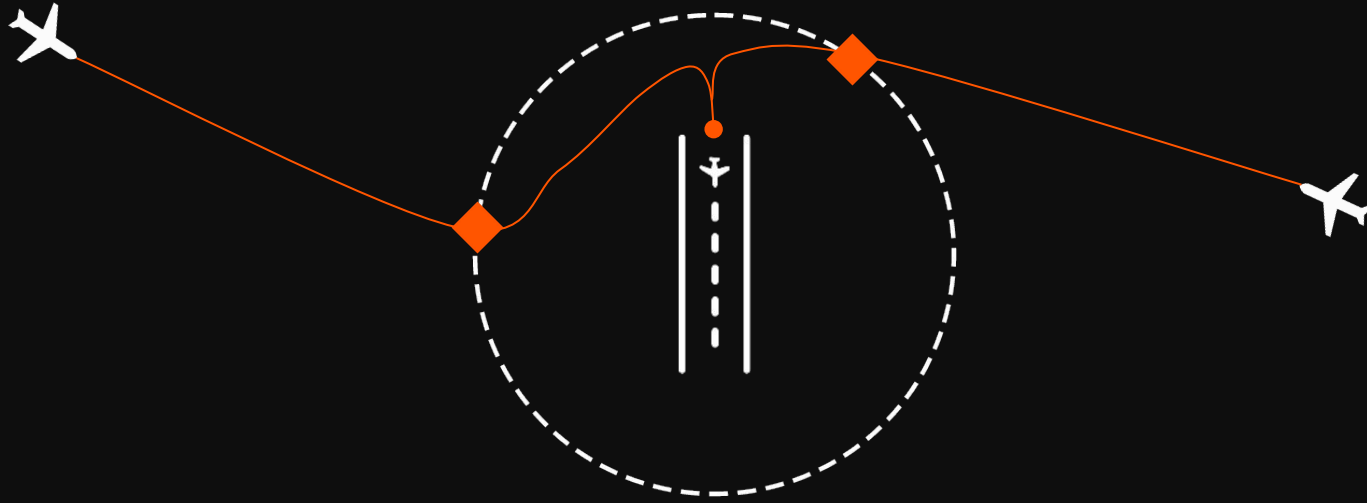
TIME BASED FLOW MANAGEMENT



TRACON

(not to scale)

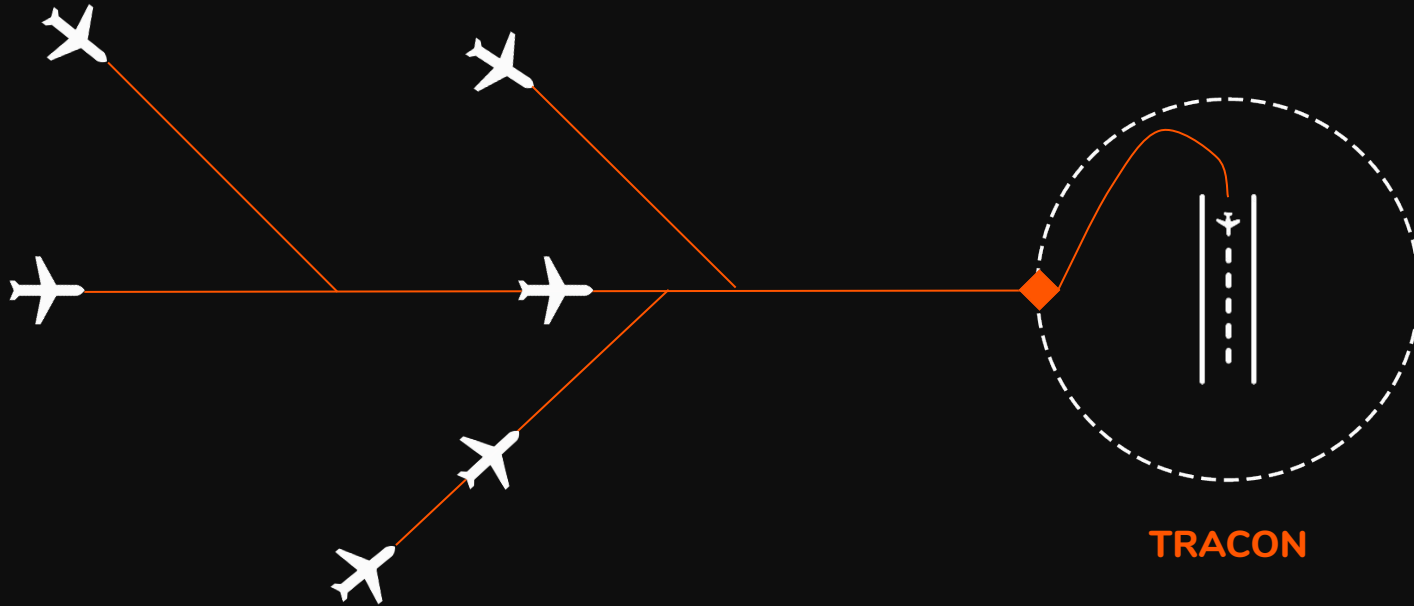
TIME BASED FLOW MANAGEMENT



MERGE IN TRACON

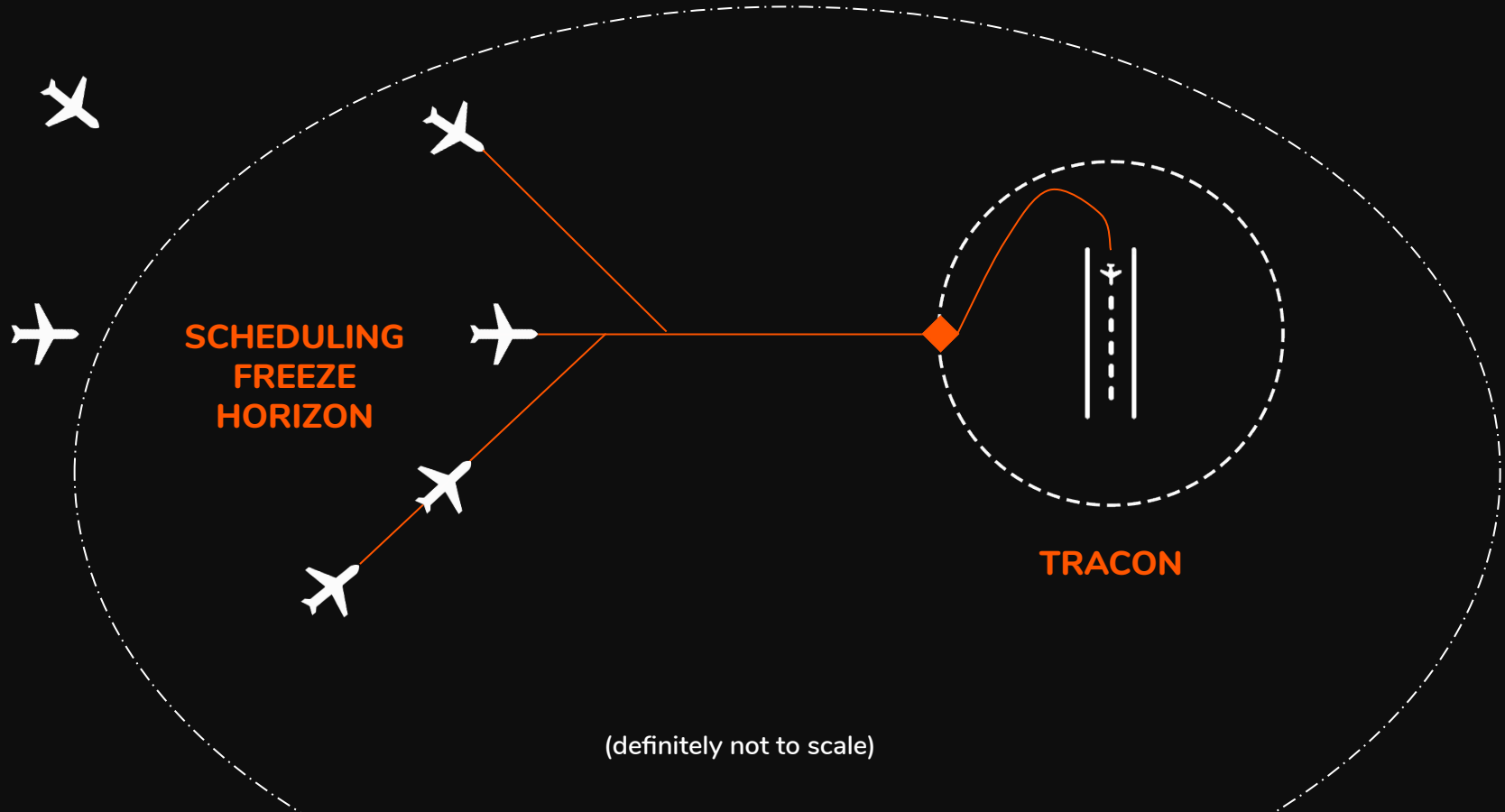
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TIME BASED FLOW MANAGEMENT

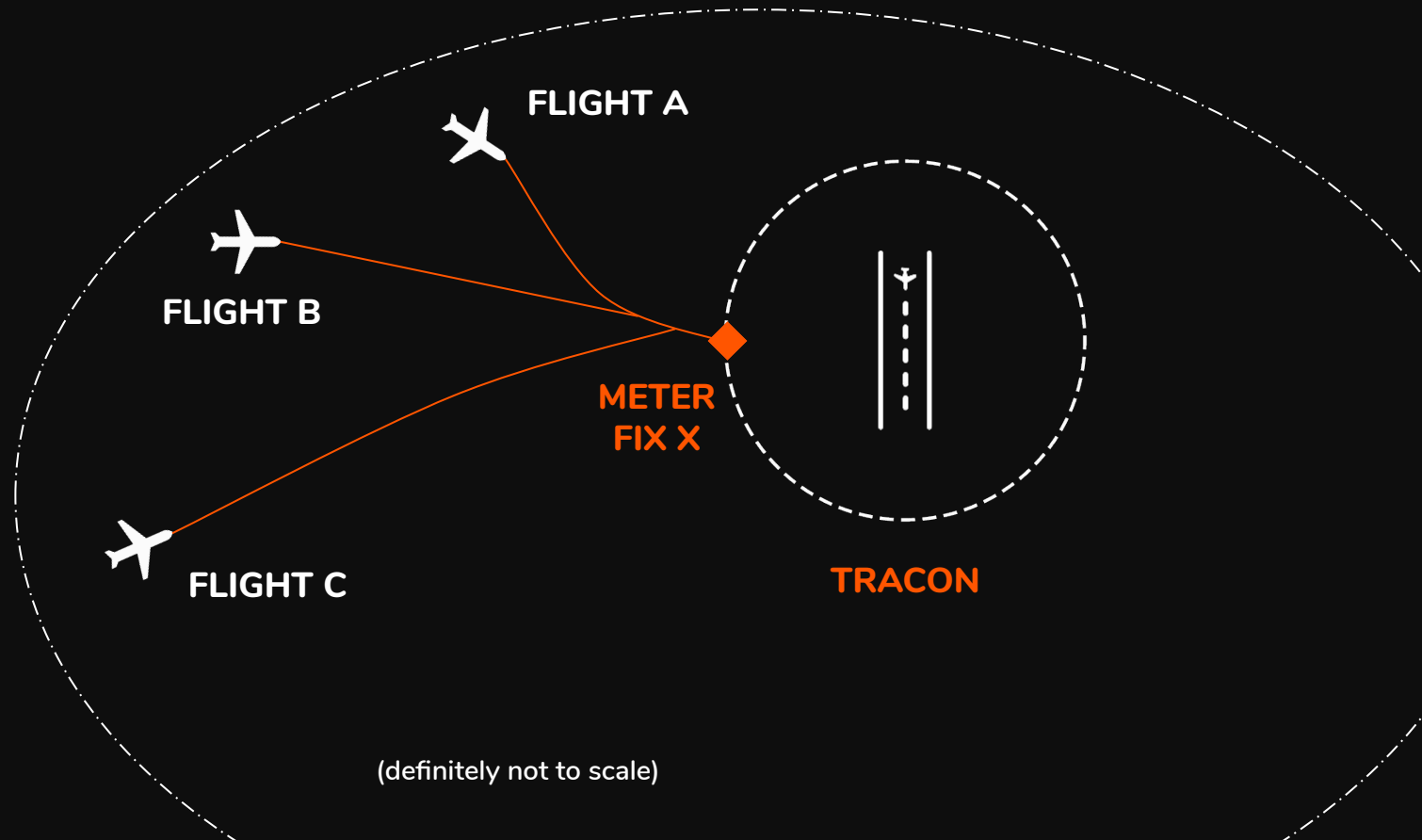


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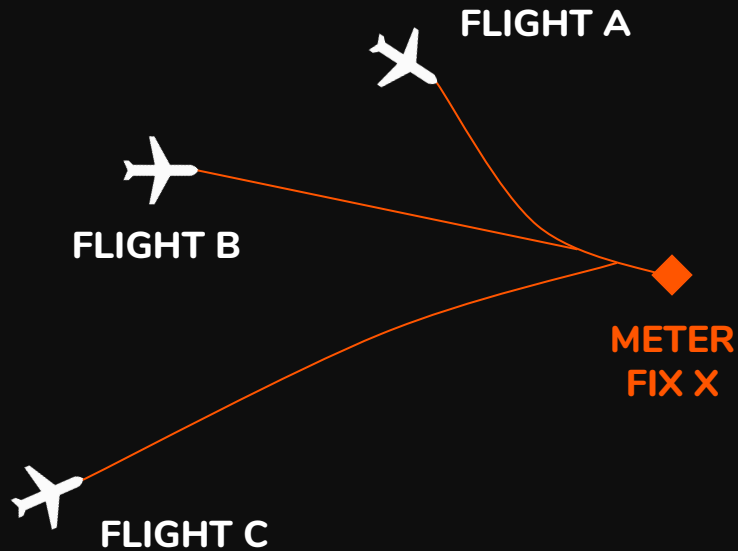
TIME BASED FLOW MANAGEMENT



TIME BASED FLOW MANAGEMENT



TIME BASED FLOW MANAGEMENT



ETA	30	STA

FLIGHT C	25	FLIGHT C

	20	
FLIGHT B	----	FLIGHT B
	15	

	10	

FLIGHT A	5	FLIGHT A

	0	

TBFM DATA DISPLAY

TIME BASED FLOW MANAGEMENT

CENTER AIRSPACE

FLIGHT A
FLIGHT B
FLIGHT C

METER
FIX X

ETA		STA
	30	

	25	FLIGHT C

	20	

	15	FLIGHT B
FLIGHT C	----	
FLIGHT B	10	
FLIGHT A	----	
	5	FLIGHT A

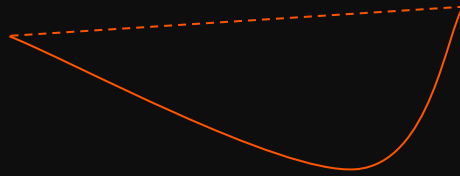
	0	

TBFM DATA DISPLAY

TRAFFIC MANAGEMENT



SPEED CHANGE



VECTORIZING



HOLDS

TRAFFIC MANAGEMENT

ETA		STA	
	30		

	25	FLIGHT C	HOLDS

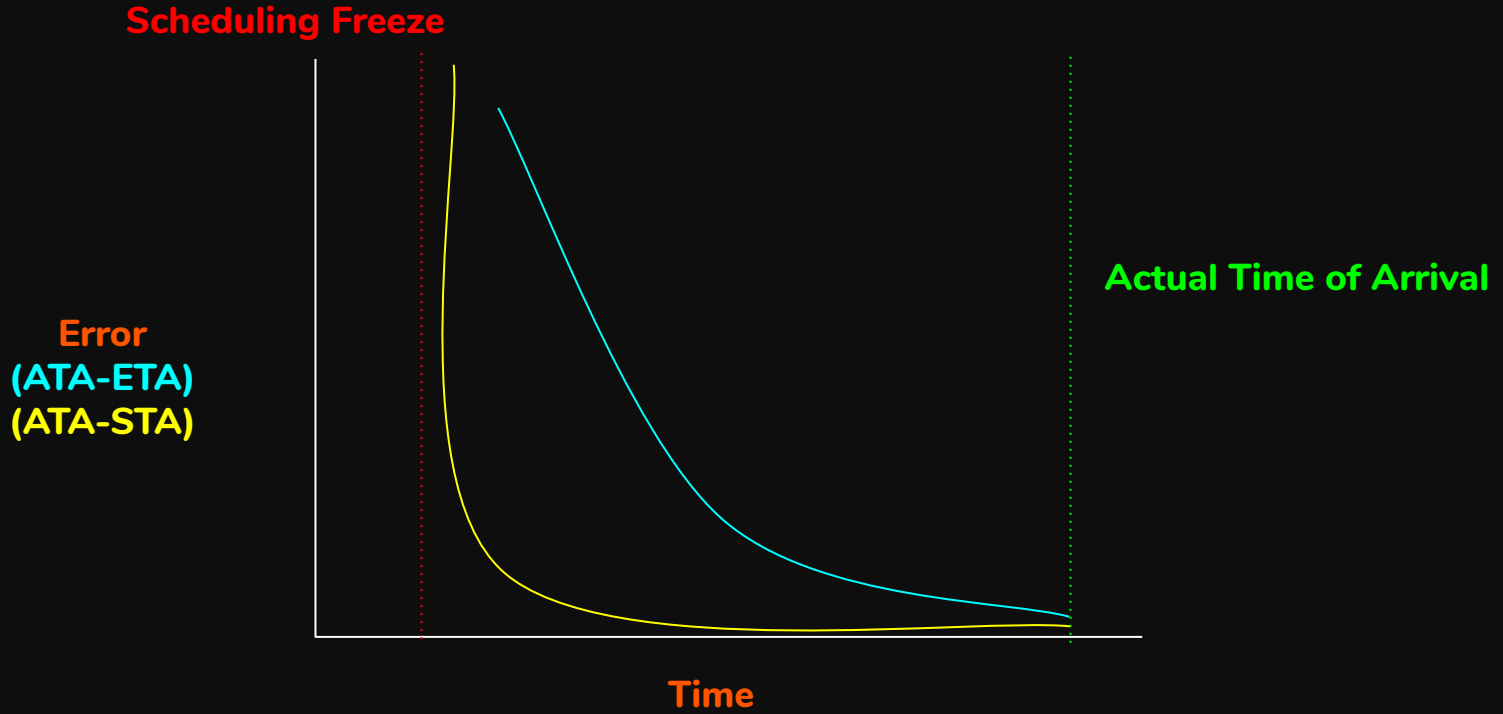
	20		

	15	FLIGHT B	HOLDS
FLIGHT C	----		
FLIGHT B	10		
FLIGHT A	----	FLIGHT A	VECTURING
	5		

	0		

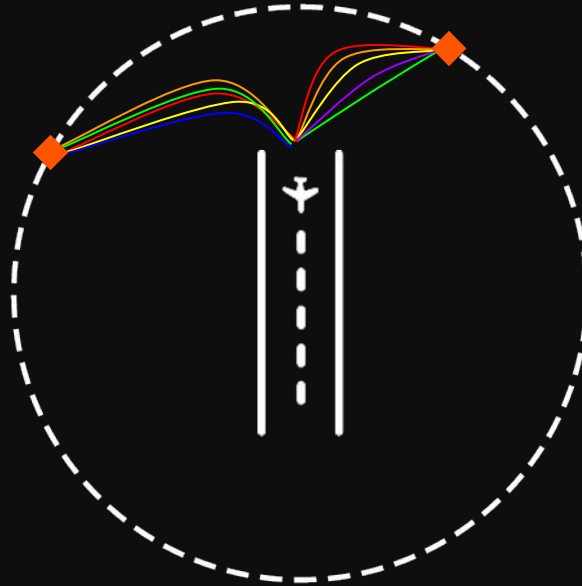
TBFM DATA DISPLAY

TRAFFIC MANAGEMENT



TRACON EFFICIENCY

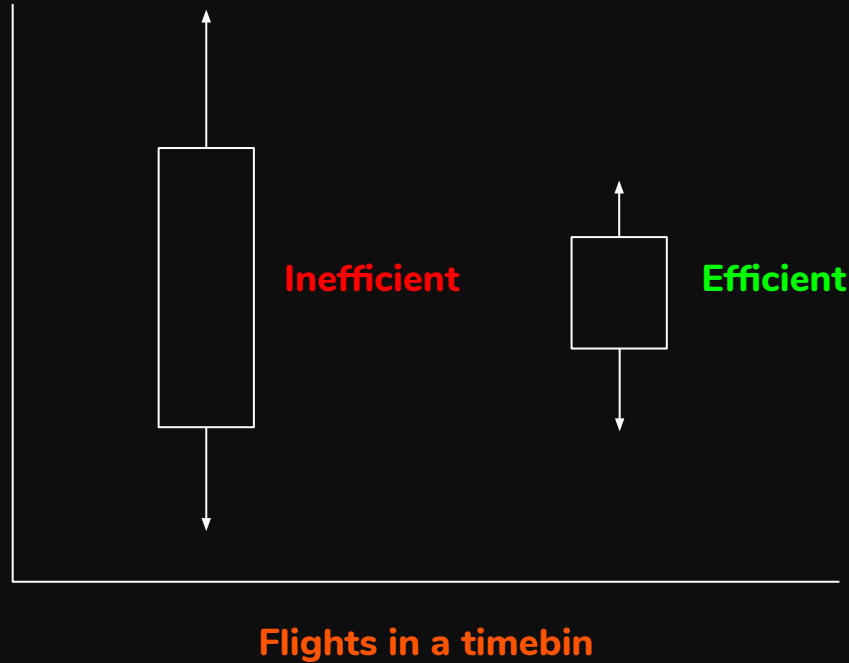
MINIMAL
VECTURING



MINIMAL
HOLDING

TRACON EFFICIENCY

TRACON Traversal
Distance



TBFM

Widespread deployment

Ease TRACON congestion

Part of FAA NextGen



HYPOTHESIS

Charlotte Douglas Intl

Newark Liberty Intl

Useful?



HYPOTHESIS

TBFM in use	TRACON efficiency	relationship
YES	HIGH	as expected
NO	LOW	as expected
YES	LOW	TBFM questionable
NO	HIGH	TBFM questionable

SOFTWARE

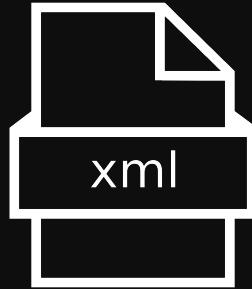
Python+Jupyter

Sherlock Data Warehouse



Dynamic tool

SHERLOCK INTEGRATION

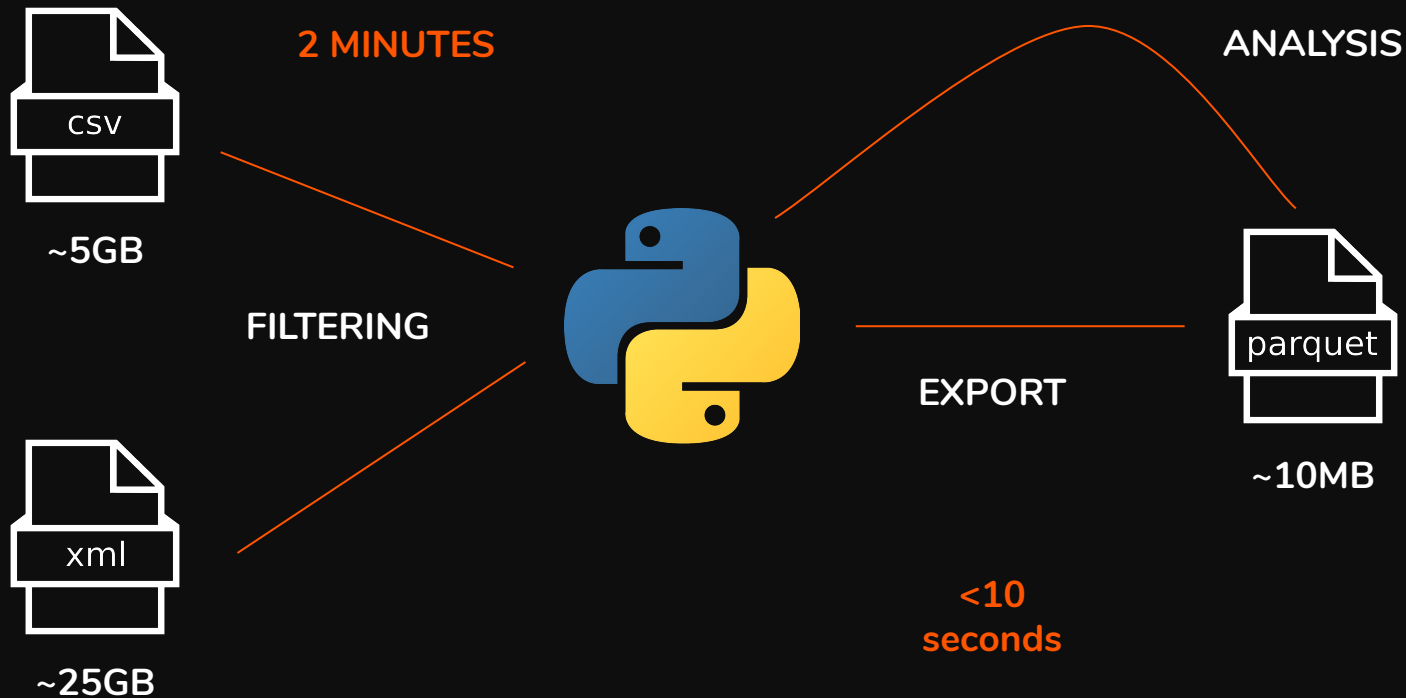


TBFM
~25GB

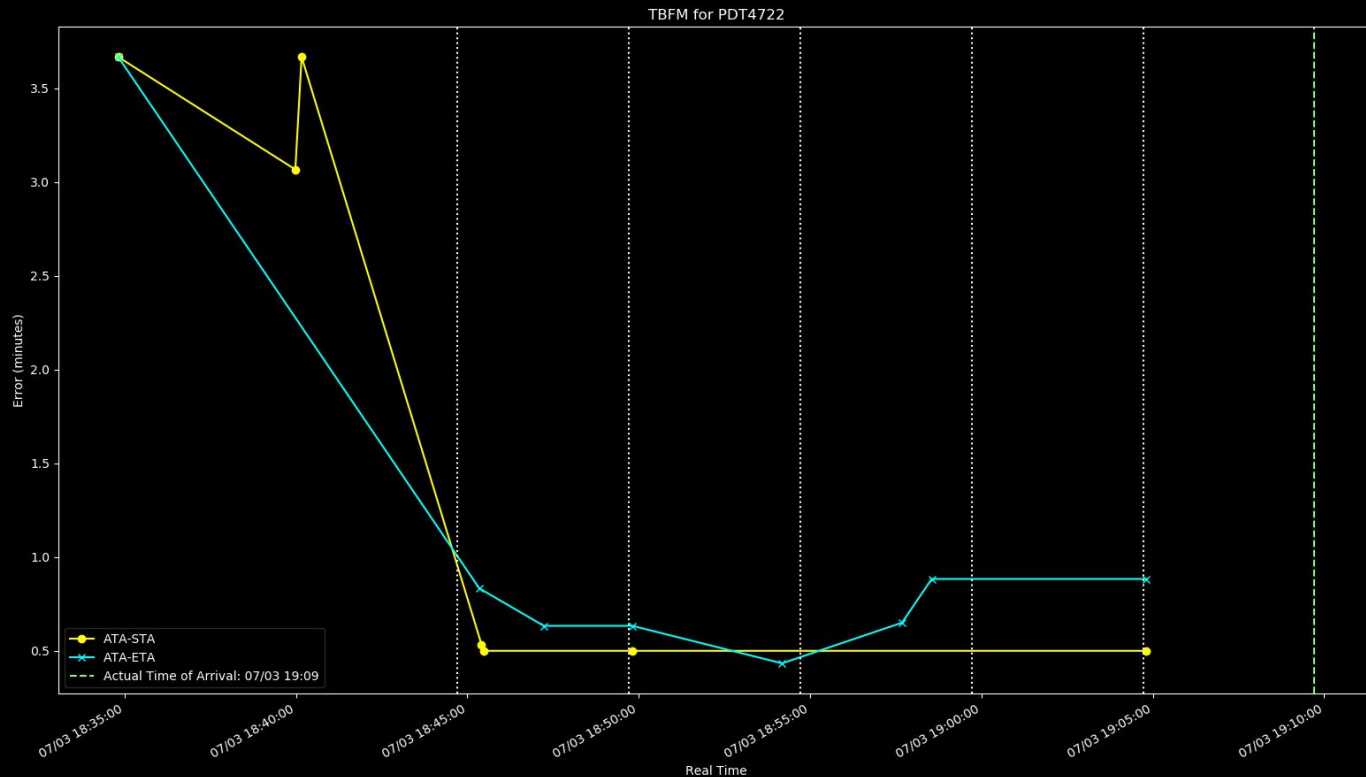


IFF
~5GB

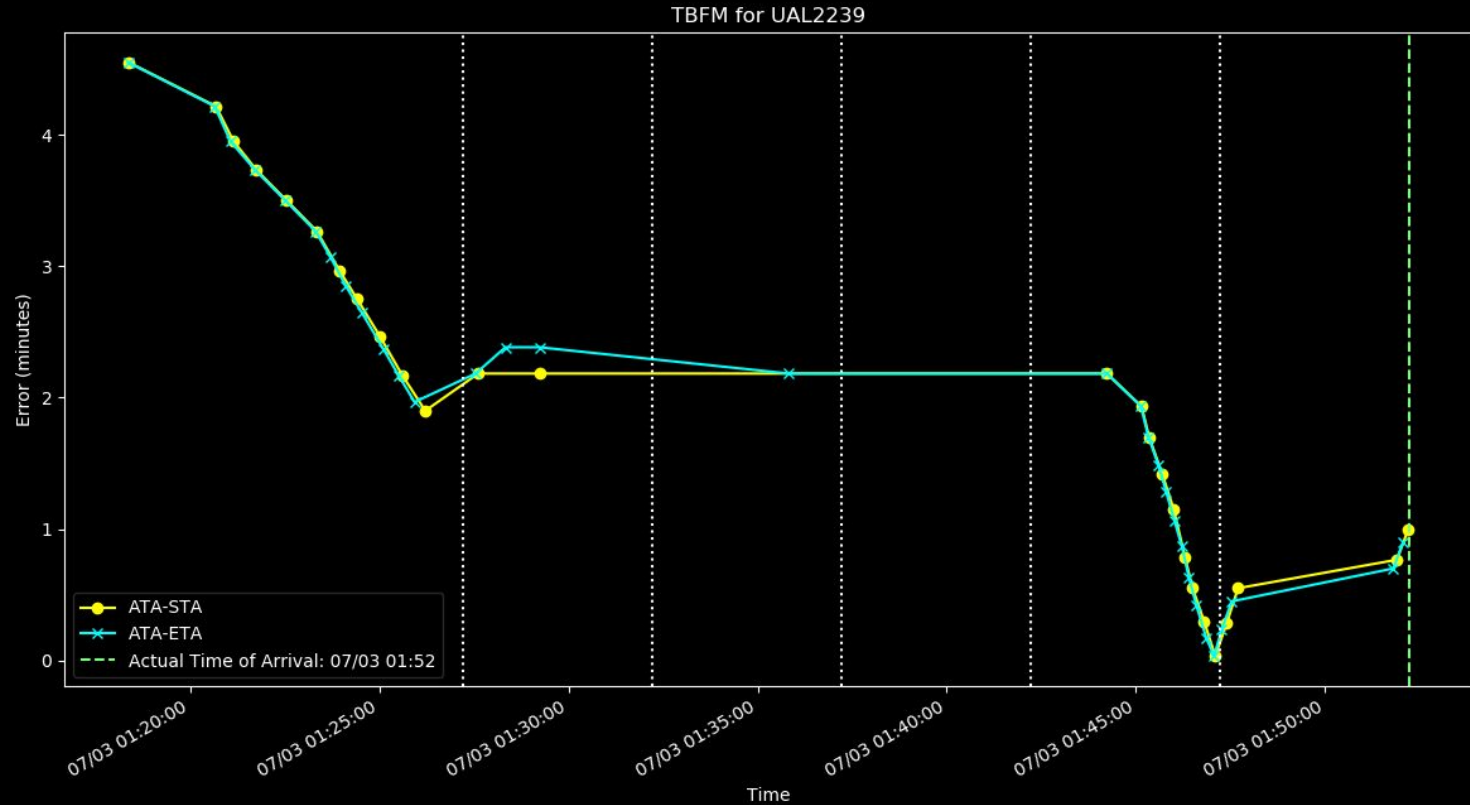
PYTHON SCRIPT



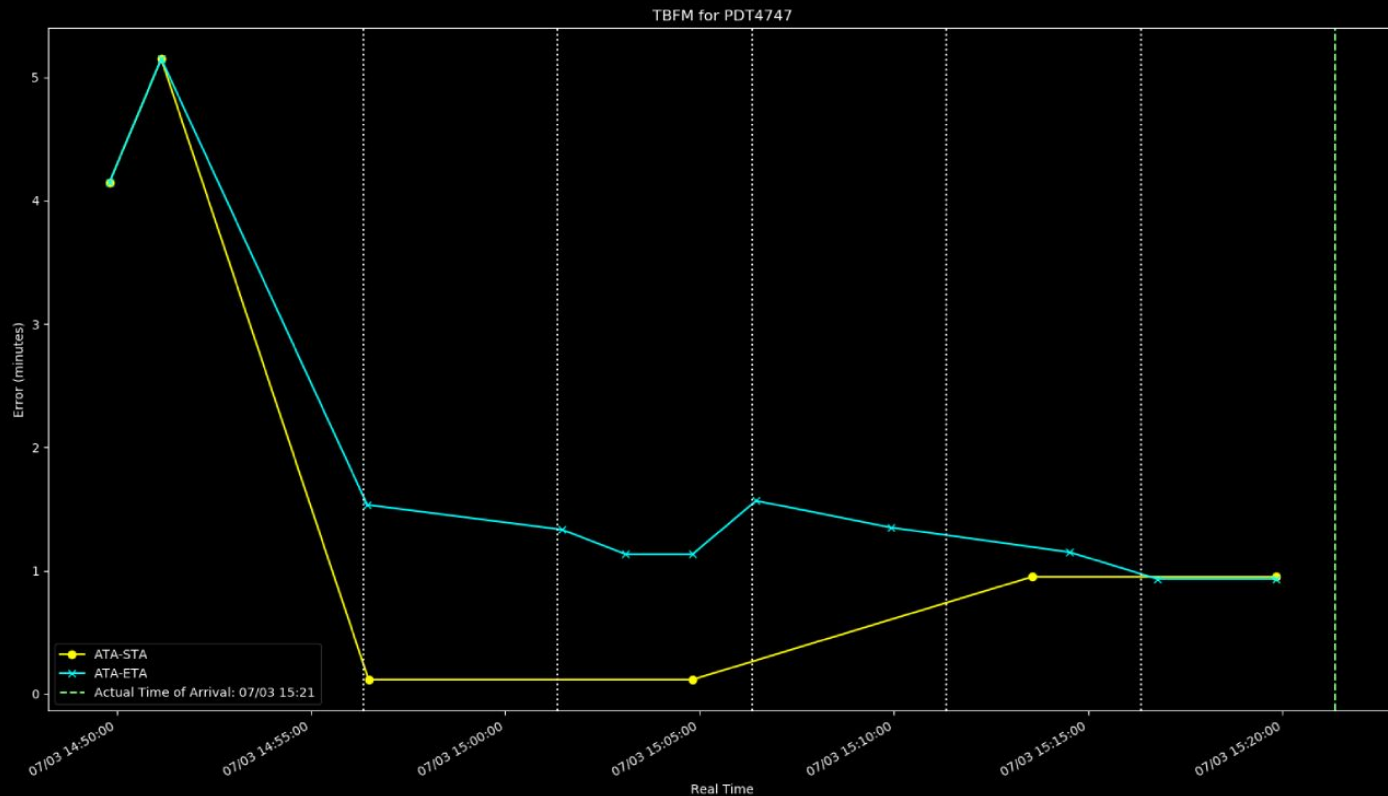
INDIVIDUAL TBFM FLIGHT DATA AT CLT



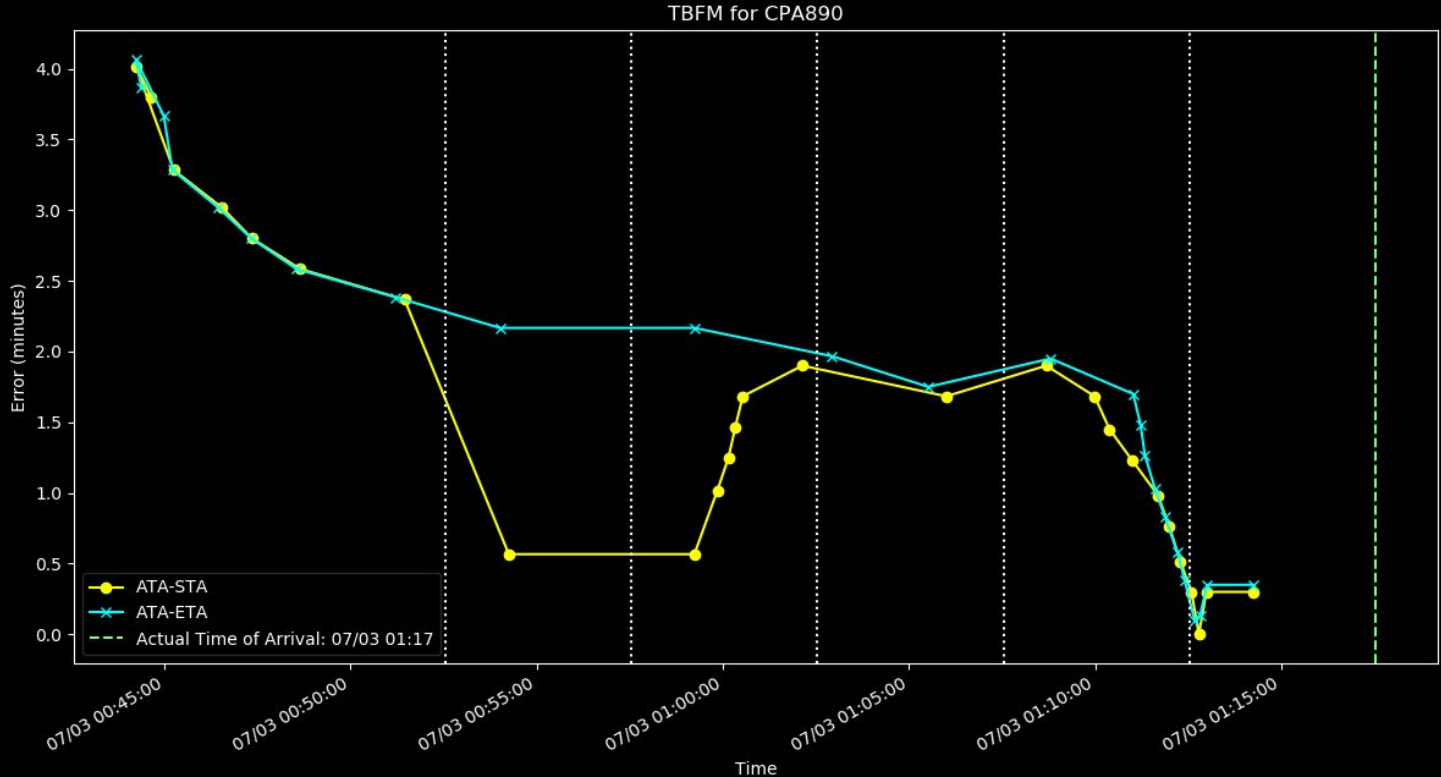
INDIVIDUAL TBFM FLIGHT DATA AT EWR



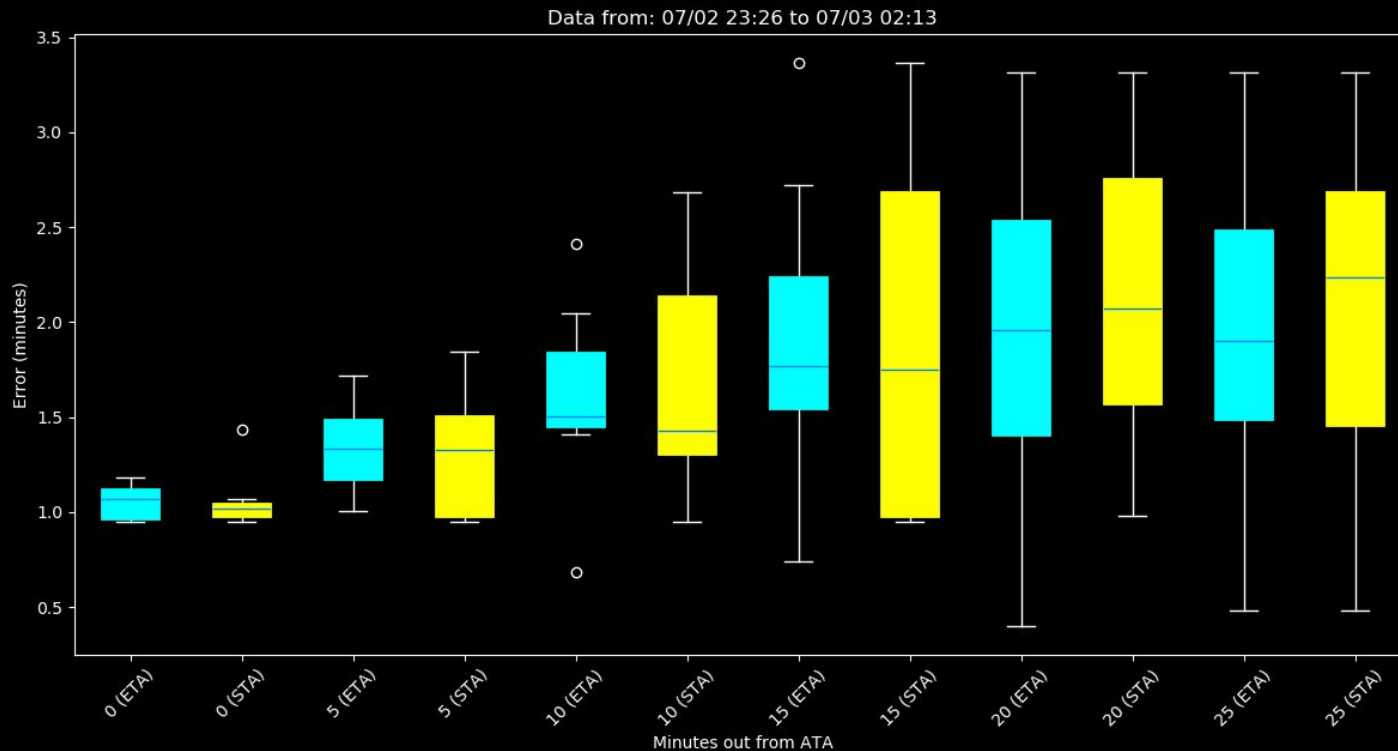
INDIVIDUAL TBFM FLIGHT DATA AT CLT



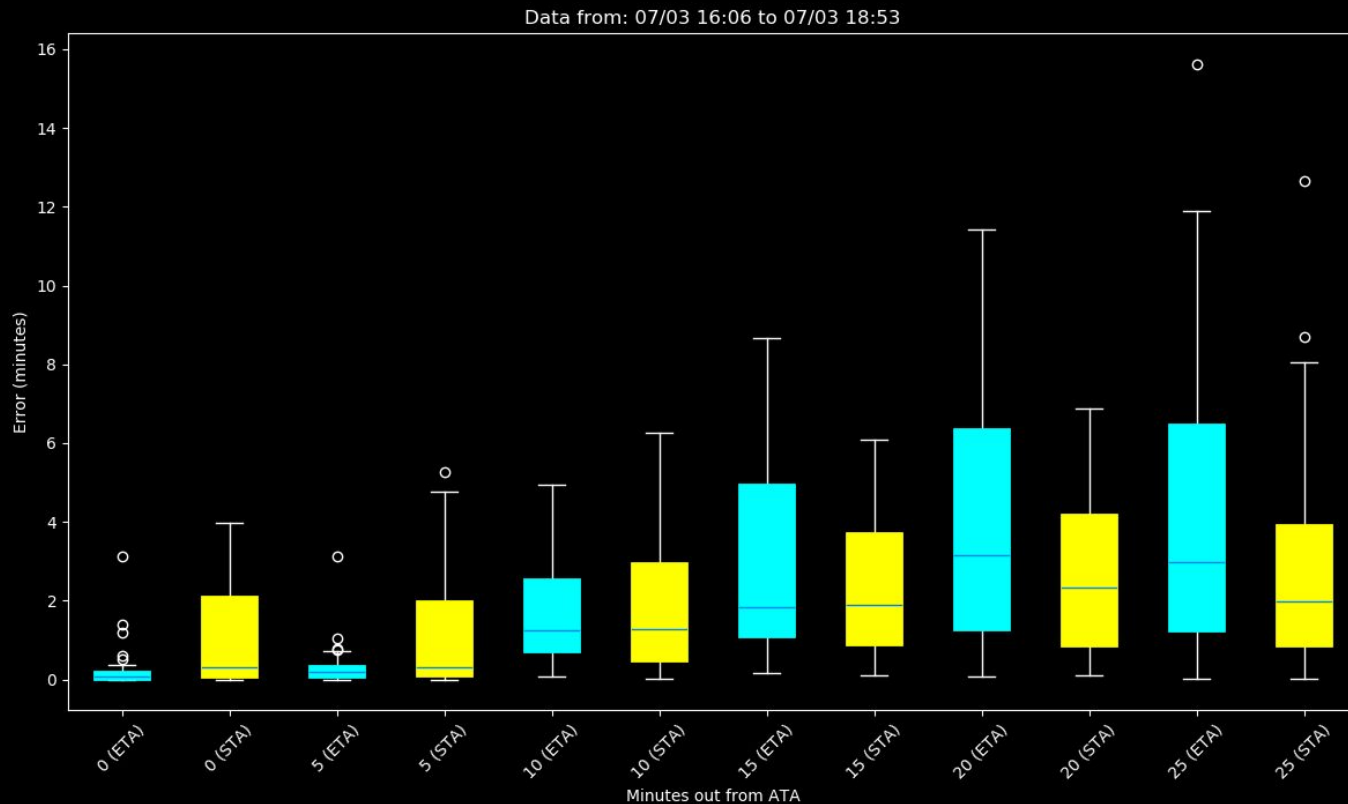
INDIVIDUAL TBFM FLIGHT DATA AT EWR



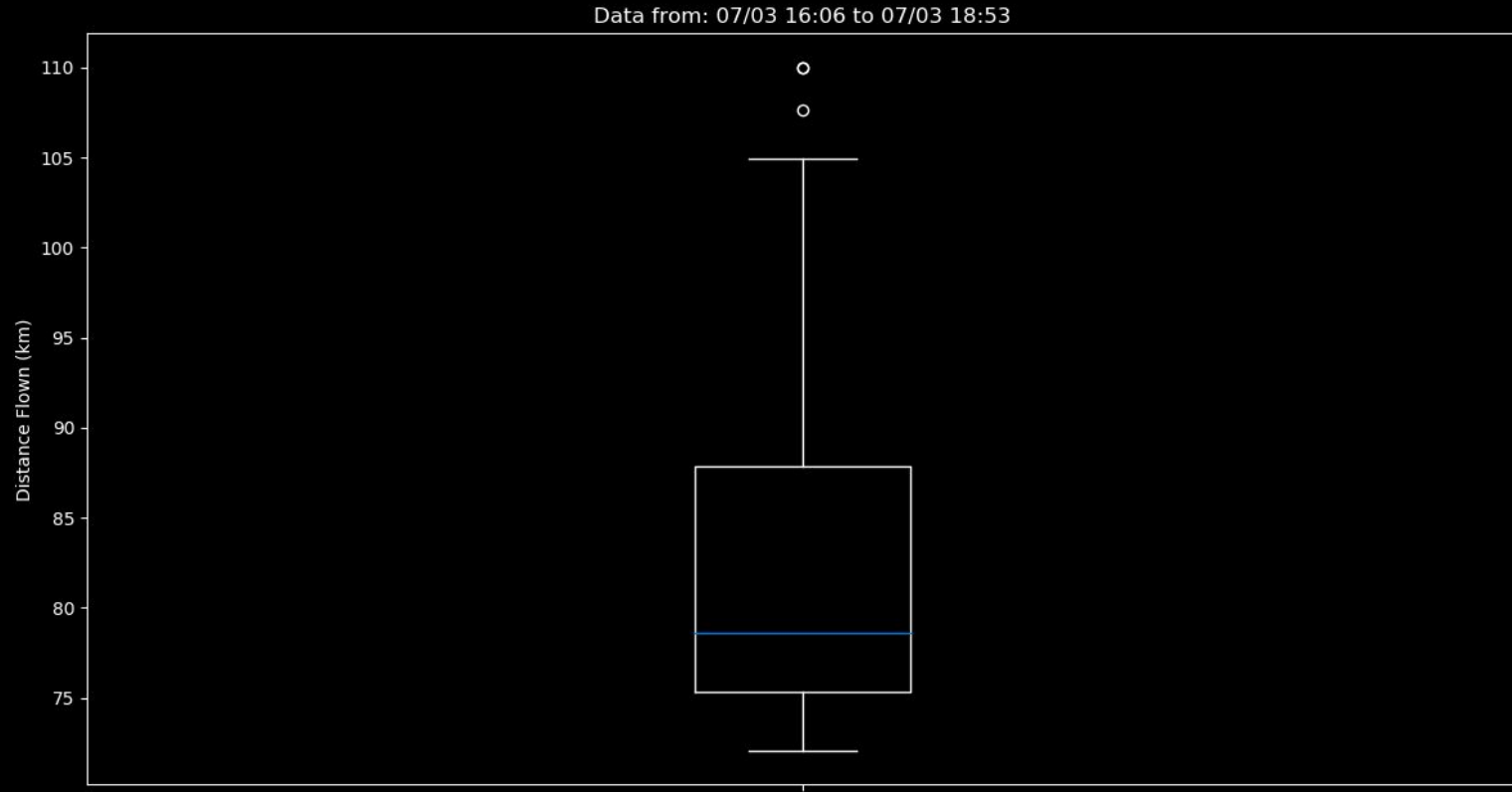
TIMEBIN FLIGHT DATA AT CLT



TIMEBIN FLIGHT DATA AT EWR

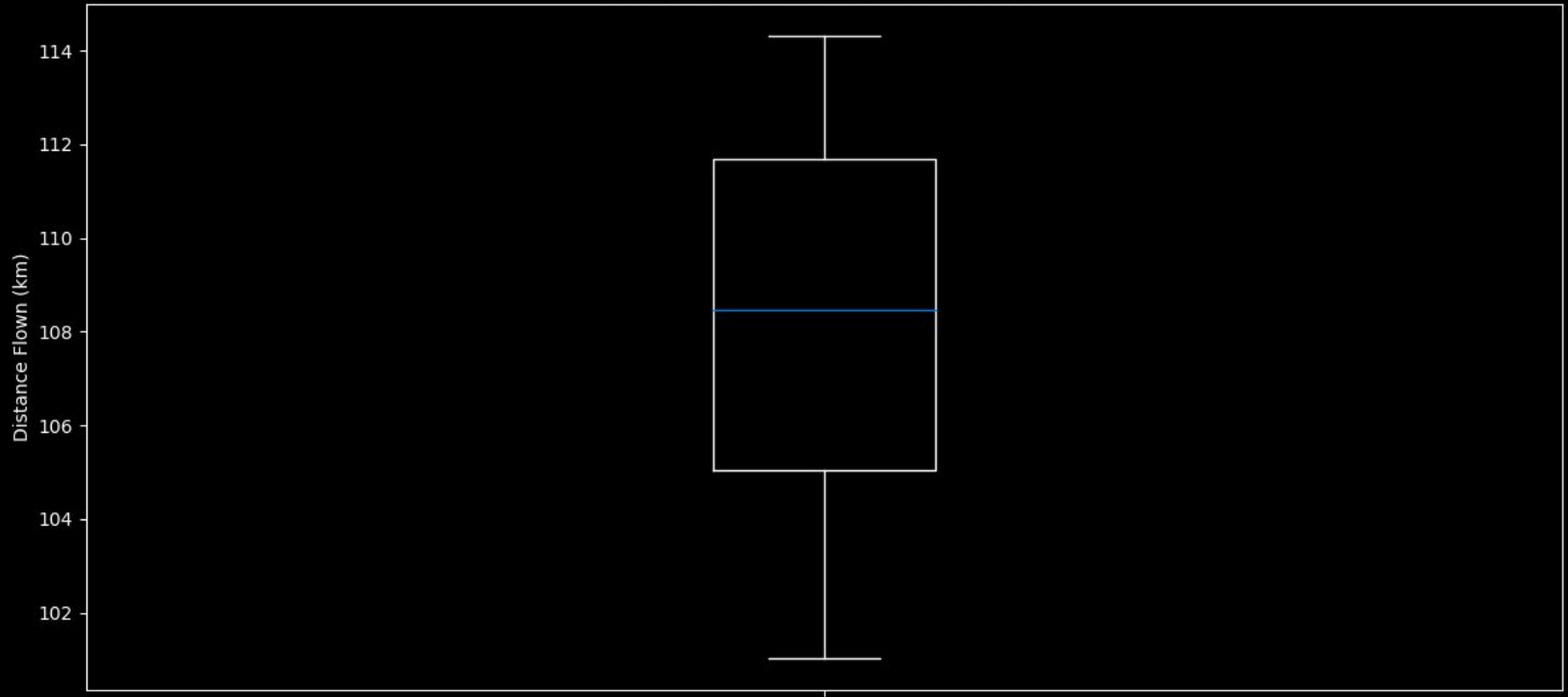


TRACON DATA AT EWR

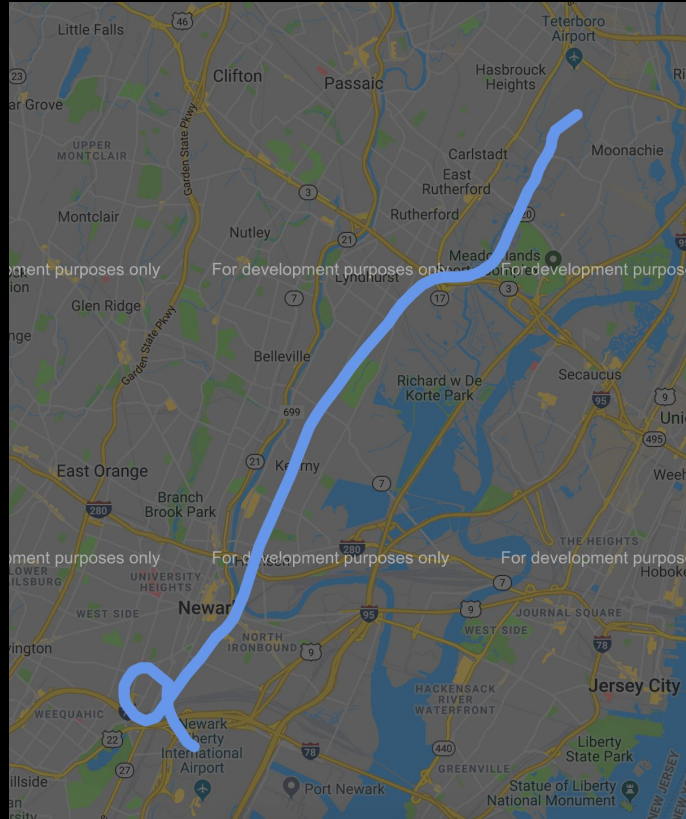


TRACON DATA AT CLT

Data from: 07/02 23:26 to 07/03 02:13



AN INTERESTING ANNOYANCE



RESULTS

TBFM in use	TRACON efficiency	relationship
YES	HIGH	as expected
NO	LOW	as expected
YES	LOW	TBFM questionable
NO	HIGH	TBFM questionable



ENDLESS GRATITUDE

Pallavi Hegde

Bob Windhorst

Heather Arneson

Liang Chen

John Schade

Jinn-hwei Cheng

Karen Gundy-Burlet

Confesor Santiago

Jeremy Coupe

One more thing...

CRITERIA

TBFM in use	TRACON efficiency	relationship
YES	HIGH	as expected
NO	LOW	as expected
YES	LOW	TBFM questionable
NO	HIGH	TBFM questionable

DATA

10 timebins daily

IQR for TRACON traversal

IQR for ATA-STA and ATA-ETA

Median for ATA-STA and ATA-ETA

TBFM ON = Low TRACON congestion

TBFM OFF = High TRACON congestion

DATA

Datapoints [10 timebins daily]

Features

IQR for TRACON traversal

IQR for ATA-STA and ATA-ETA

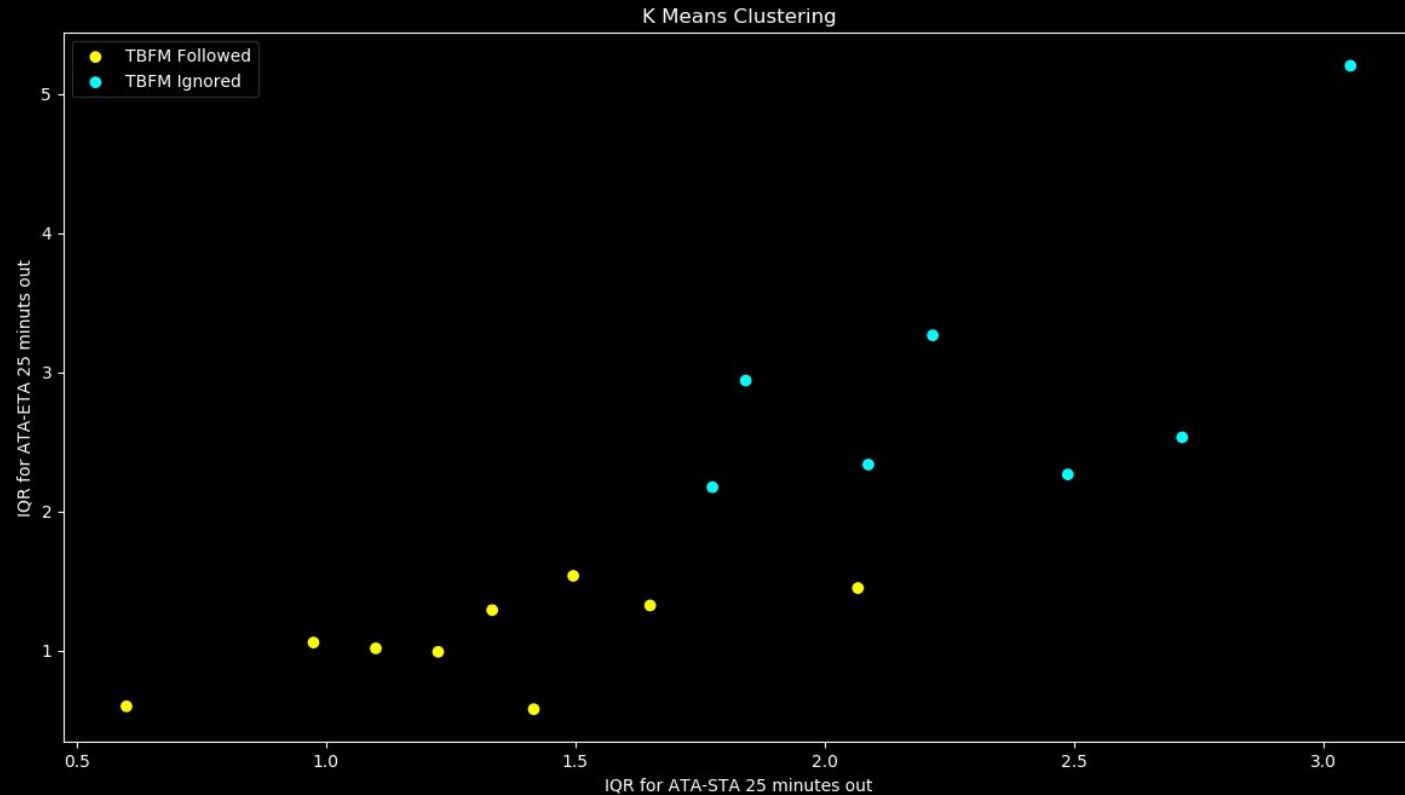
Median for ATA-STA and ATA-ETA

Clusters

TBFM ON = Low TRACON congestion

TBFM OFF = High TRACON congestion

MACHINE LEARNING



MACHINE LEARNING

