SANS
خدمات الملاحة الجوية السعودية
Saudi Air Navigation Services

Data Analytics In Air Navigation Service Providers

Primer – ICAO RUH ADAS Conference

DEC 2024

BEYOND

About Speaker

- Wesam Ibrahim Hussain
- +16 years exp, **+8** years in **S**audi ANSP
- Currently head of Analytics and data science in Saudi Arabian Air navigation company SANS
- Strategic planning, Kaizen, Analytics and Data management

Introduction

About Saudi Arabian Air Navigation Services Company (SANS)

2016 ***Establishment***

SANS was **established** by the General Authority of Civil Aviation (GACA) (T/260) on Ramadan 26, 1437 H, and officially commenced operations on July 1, **2016**

Vision

To be a **globally** best-in-class air traffic services, solutions, and innovative technologies provider.

Mission

Providing outstanding Air Navigation services at a **global level** across mandated and commercial business, enabled by its recognized leadership in safety, efficiency, and technology innovation.

Services

- Air Traffic Management
- Aeronautical Information Management
- Search & Rescue
- Engineering Services
- Maintenance Engineering Services

SANS In Numbers

1,200+ System Components

- **73** Automation
- **335** Navigation
- **30** Surveillance
- **602** Communication
- **238** Environment

1,850+ Employees
96.5% Saudis

- **6%** Technical Engineers
- **3%** Aeronautical Experts
- **47%** Maintenance & Technical Support
- **36%** Air Traffic Controllers
- **7%** Air Traffic Management Expert
- **3%** Safety & Quality Expert

56 Sites Managed

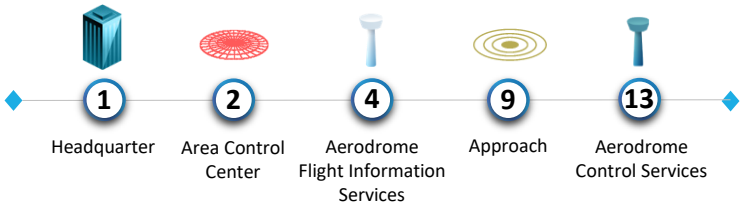
- **28** Airports
- **9** Military
- **19** Remote

27 Infrastructure Development

- **12** Others
- **8** Comms
- **3** Radars
- **4** NavAids

* 27 Development Projects in 2022

SANS BUILDINGS IN KSA



~945,862 ✈
HANDLED FLIGHTS / YEAR

~2,584 ✈
HANDLED FLIGHTS / DAY

*** All metrics are as of 2023, except for No. of flights managed is as of 2024 Closing Estimates*

Saudi Arabian FIR In Numbers (OEJD)

2024 Traffic Overview

+945 K Total Flights

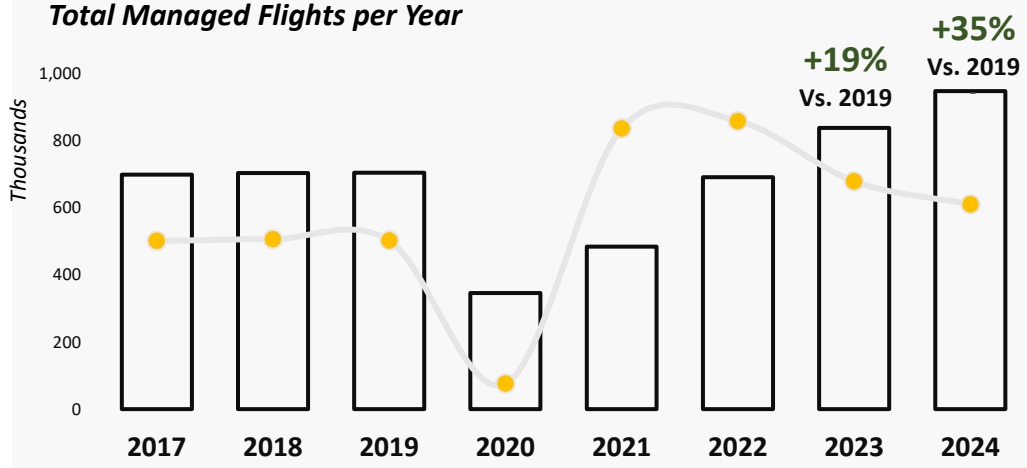
+2,580 *Per Day* 108 *Per Hour*

+13%
Vs. 2023

+1,020 Unique Acft. *Per Day* **+60%** Vs. 2019

+987 Unique City Pair *Per Day* **+45%** Vs. 2019

Total Managed Flights per Year



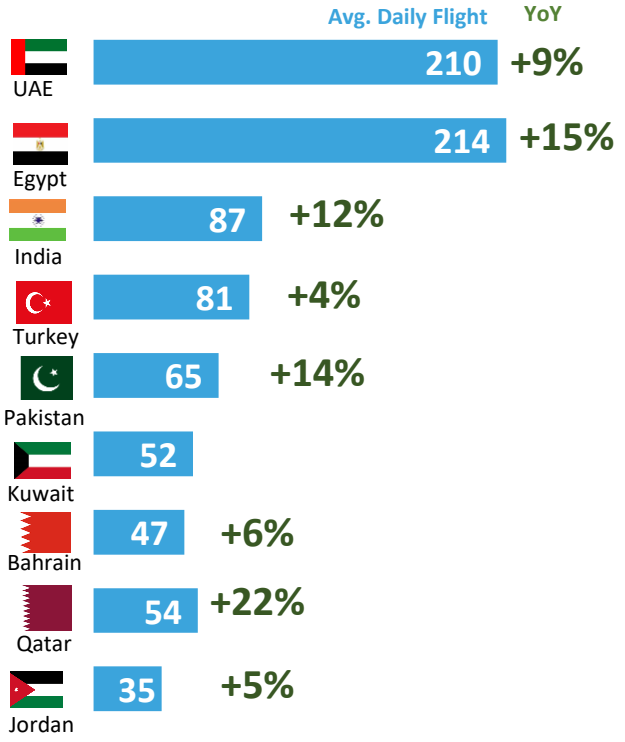
Segment Share

Domestic
+700 FLT *Per Day*
30 *Per Hour*
27% Share

International
+1,180 FLT *Per Day*
50 *Per Hour*
46% Share

Overflights
+690 FLT *Per Day*
29 *Per Hour*
27% Share

Top International Flights



About Analytics & Data Science Organization In SANS CO.

2019

- **4** BI developers
- Descriptive reports (Safety, ATM)
- Managed dashboards
- Saudi FIR strategic flows prediction model

2020

- COVID
- Service units and Cost Analytics
- Recovery scenarios

2021-2022

- **7** Analysts/engineers
- **O**fficial office letter with **G**ACA
- **S**elf service dashboards (Safety, ATM)
- **C**ANSO/**I**CAO **K**PIs reporting

2023

- Department **v**ision, mission and strategic aspirations
- SANS data management and analytics **s**trategy
- Future **i**nitiatives, **u**se-cases implementation plans

2024

- **16 A**nalysts/**E**ngineer
- **O**M and **O**D development
- **+ 30** ATM/ Safety decision making **d**ashboards
- **B**espoke Analytical **a**pplications

About Analytics & Data Science Organization In SANS CO.

"***Empower*** Saudi Air Traffic Operations by ***unlocking gains*** in operational efficiencies, safety readiness, processes optimization and overhead management through ***thoughtful use of enterprise data and analytics capabilities, solving complex and innovative streams*** challenges and uncovering enhancement opportunities"

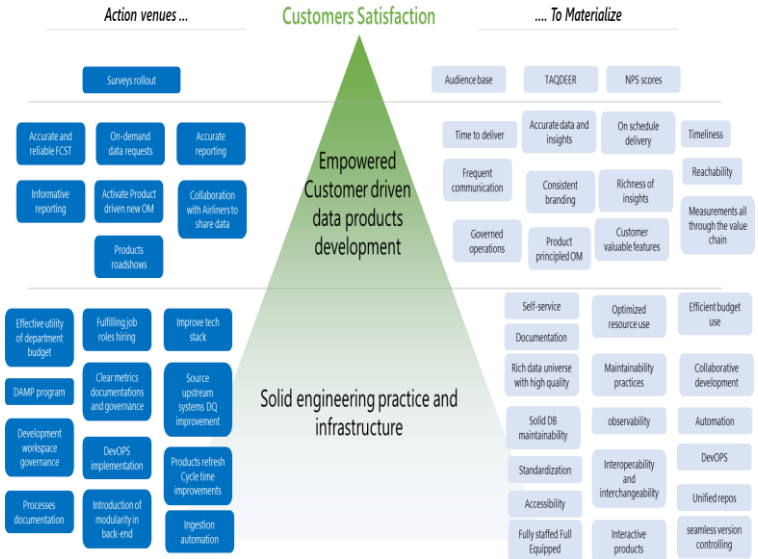
About Analytics & Data Science Organization In SANS CO.

Service Model

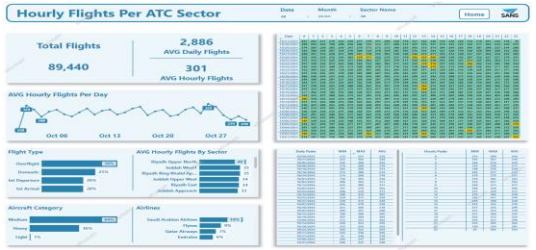
Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• MED/ESD engineering • OT security • IT APP services • IT infrastructure • IT Security • CRM team • Premium data providers • ANS associations • Airports network planning • Airliners network planning • Local regulator | NDMO | Permits | MIL	• Complex workstreams • General Consultation • Desc. Stats. and Viz. dev. • Ad-hoc analytics cases • Models and metric layers • DS modeling • Data reconciliation • Data products req. • Data sourcing	Data-driven diagnostics, data solutions discovery, and development yielding insights on: • Operational capacities bottlenecks and efficiency state • Optimization opportunities • Revenue sources and developments • Performance and regulatory conformance • Demand predictability and scenario planning	• Full outsourcing • Complex stream offloading • Activation & turnkey • Consultation • Setup support • IT/MED mediator • Eng. Workloads • Resource lease	Internal • SANS support dept. • ASM • ATM Safety • ATM OPP. • ATM performance • SQE Safety • Finance • CEO office • C-suite External • GACA • ICAO • MID-ICAO • NDMO • Regional ANS
	Key Resources • ATM/IT Data marts. • BI Dev's, DS's, DEs, Architect, SWE. • Premium industry data • Enterprise DAMP and servers • Viz: PBI Premium capacity • MS office 365 suite • Custom analytics APPs • Colab (Azure DevOPS) • DE/SE and DS APP stack		**Channels** • BI reports • Spreadsheet models • Data models • DS models • Curated data sets • Custom applications • Presentations/cases • Training • DAMP	

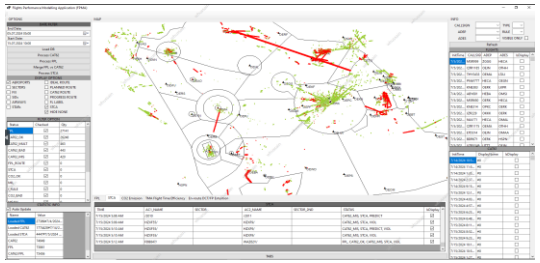
Cost Structure	Revenue Streams
• FTE cost • Premium industry data • Laptops and Tooling and related licensing • Analytics managed infra. (VM/Server/DAP) • 3rd parties consultation fees	• Analytics products or artifacts embedded in commercialized SANS/NERA APPs

Operations As Customer



Interactive Decision Making Solutions

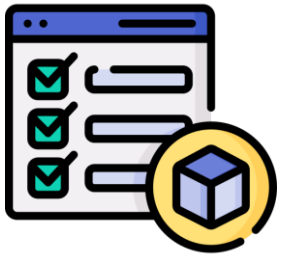




*** Exhibits from SANS CO products and tools; Data exhibited is randomized for illustration purposes only*

About Analytics & Data Science Organization In SANS CO.

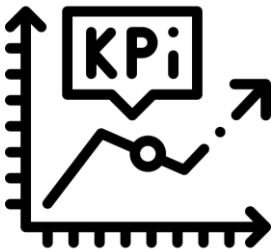
+100
Active user



+300
Releases in a year

+10
External entities with frequent data exchange

+5
Full fledge analytics dev. env.



+15
GANP/ CANSO KPIs reported frequently

+30
Managed self service dashboard

SANS
خدمات الملاحة الجوية السعودية
Saudi Air Navigation Services

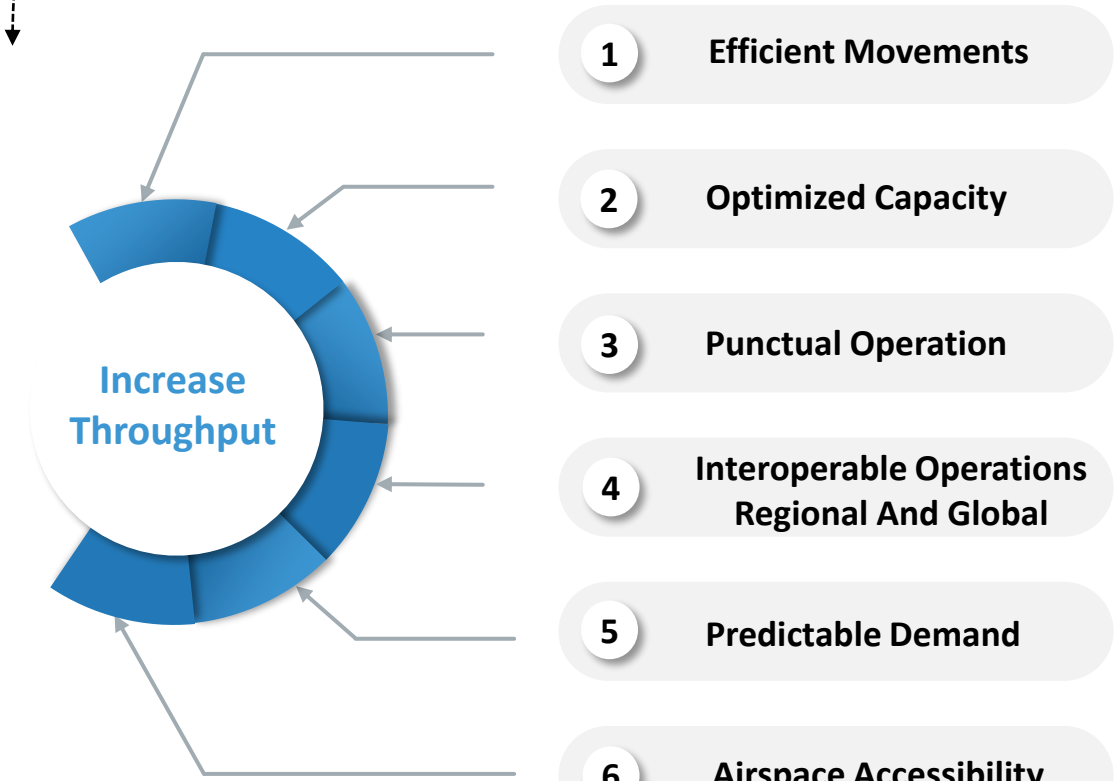
MANAGING SKIES
SECURING LIVES

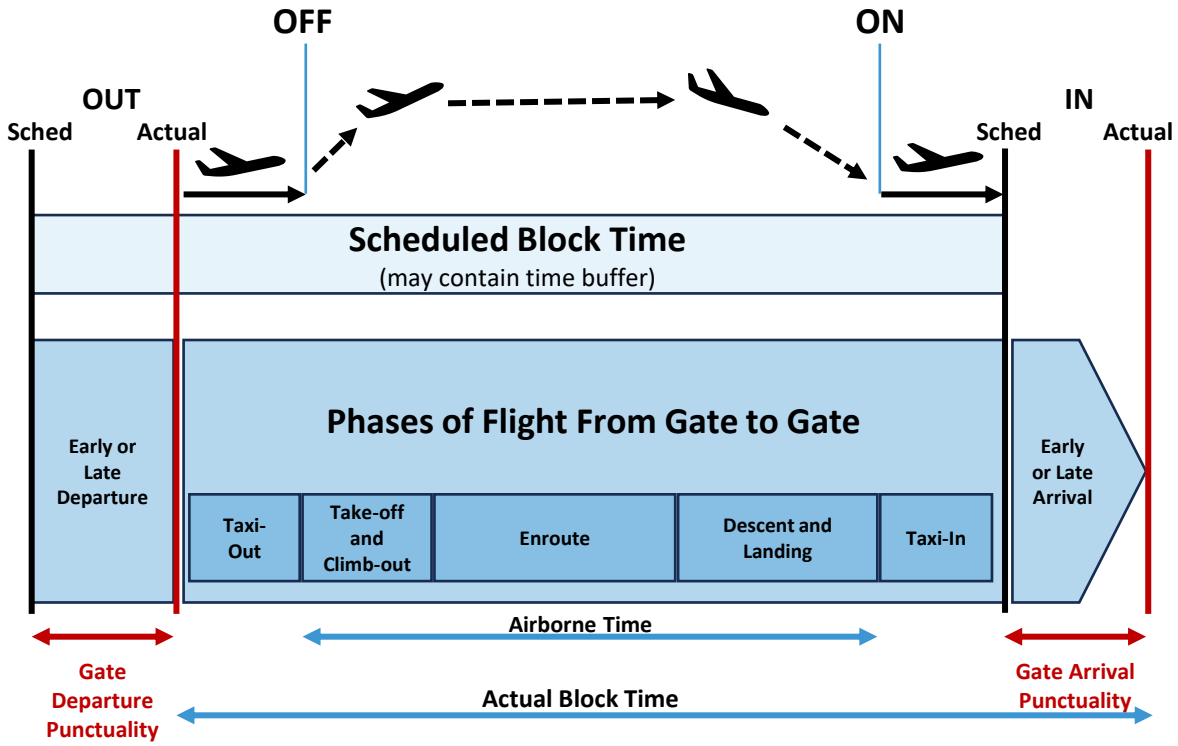
Data Analytics in ANSPs

BEYOND

What Is The Objective Function Of An ANSP ?

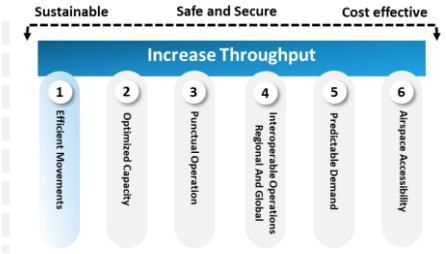
Sustainable Safe & Secure Cost effective



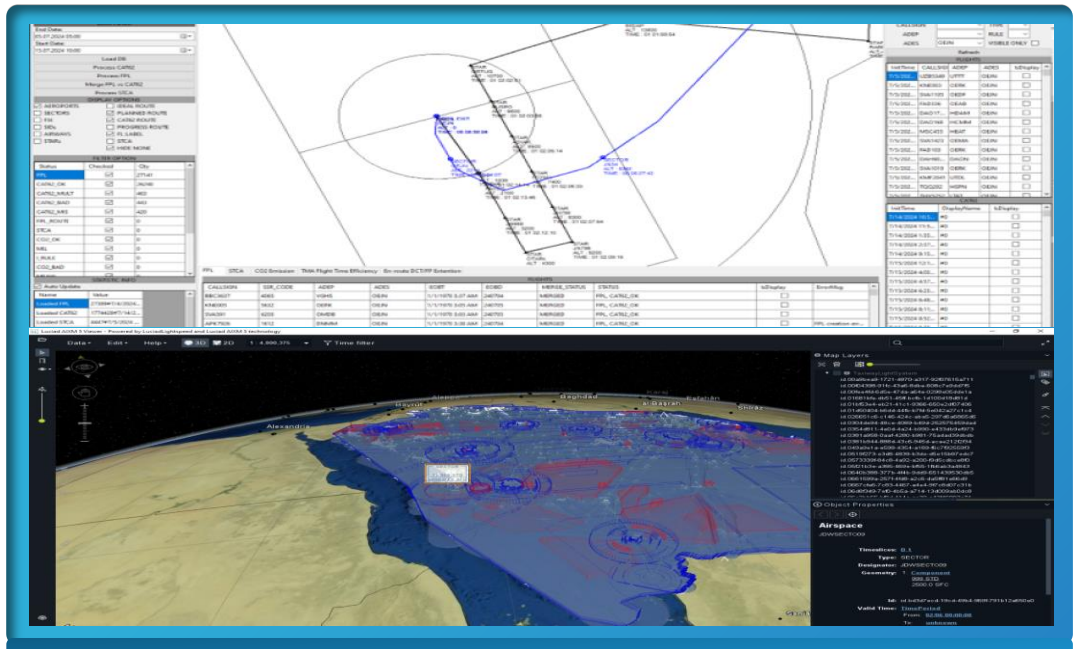


*** Courtesy of ICAO GNAP portal; Courtesy of CANSO publications, Assumptions made by Author related to ANSP objective function*

Analytics Use-cases | Optimizing For Efficient Movements



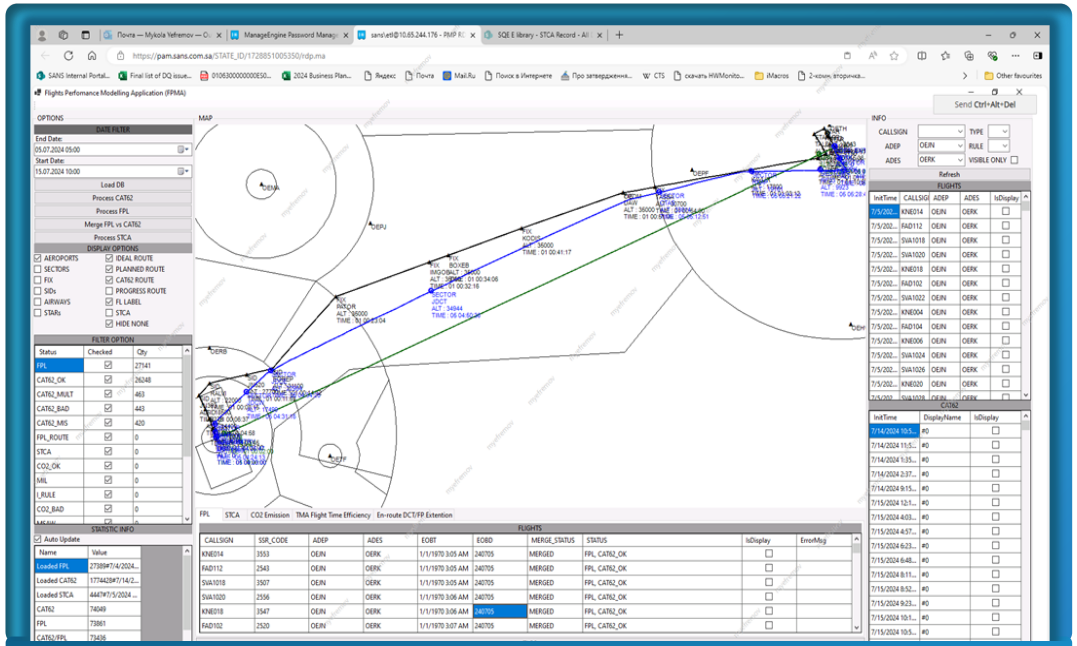
Flight Performance Modelling Application (FPMA)



TMA | En-Route Trajectory | AIXM

- Climb And Descent Cycle Time
- 4D Flight Profile Optimization
- Utilize FPL data and CAT62 radar messages for post-operations analysis.

Enroute efficiency

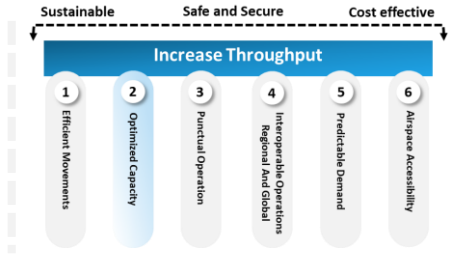


Enroute radar VS. FPLs

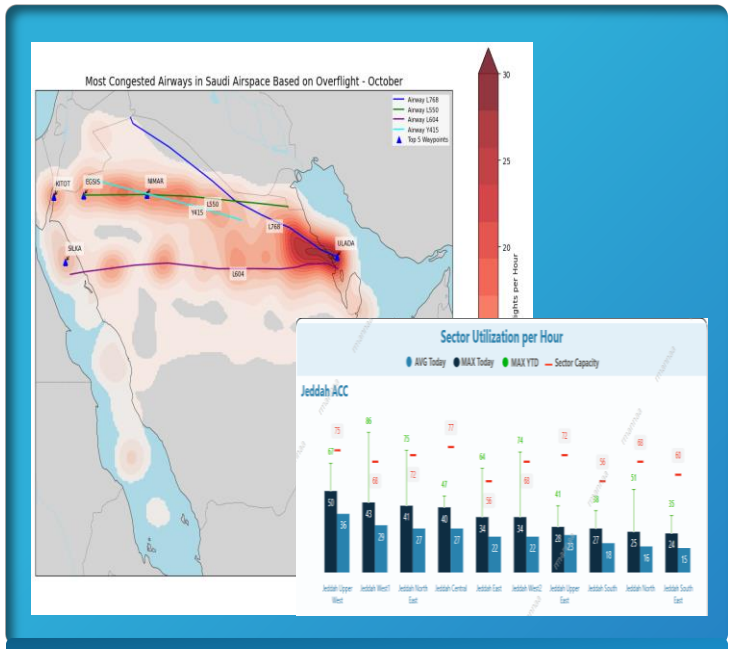
- Average delays for departures and arrivals.
- Percentage of flights adhering to assigned SIDs and STARs
- Average fuel consumption of flights using SIDs and STARs
- Number of aircraft using SID and STAR routes

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics Use-cases | Optimizing Airspace Capacity



Sector Utilization and Airways Congestion



Airways| Waypoints|Sector

- Monitoring Sector Capacity
- # Avg. Hourly Flights per Airway

Apron and Runway Analysis

Airports | Runway | Terminal | Apron

- # Hourly / Daily Flight per Apron
- # Hourly / Daily Flight per Runway

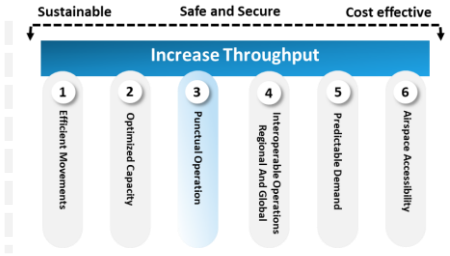
Rostering and Planning

ATCO Utilizatoin

- Utilization and Achievement Hours
- # ATCO Position per Year
- Effective Time per ATCO

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics Use-cases | Punctuality

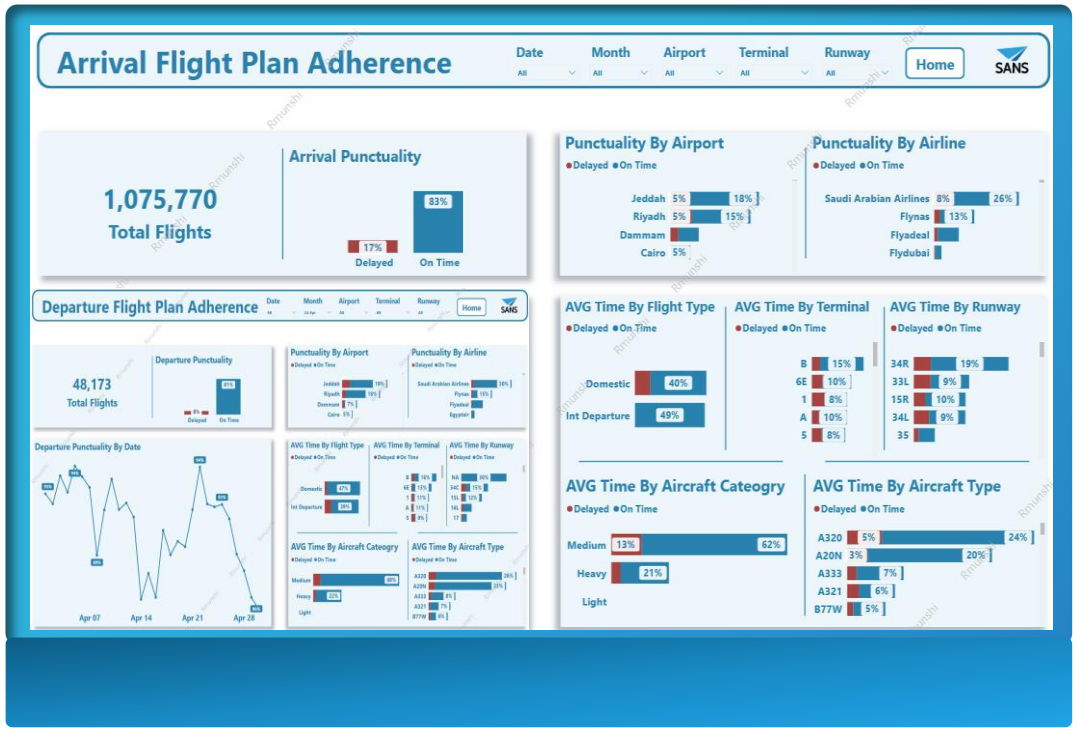


Seamless Operation

4 Airport | 177 initiatives | 25 Stakeholders

- RWYs System capacity
- Turnaround Time Adherence
- On-Time Performance for Arrivals and Departures

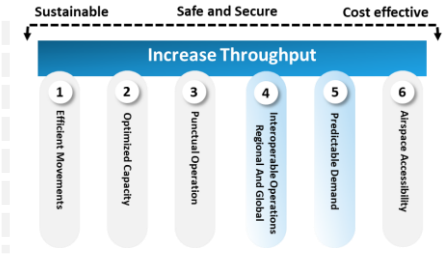
Air Space Management



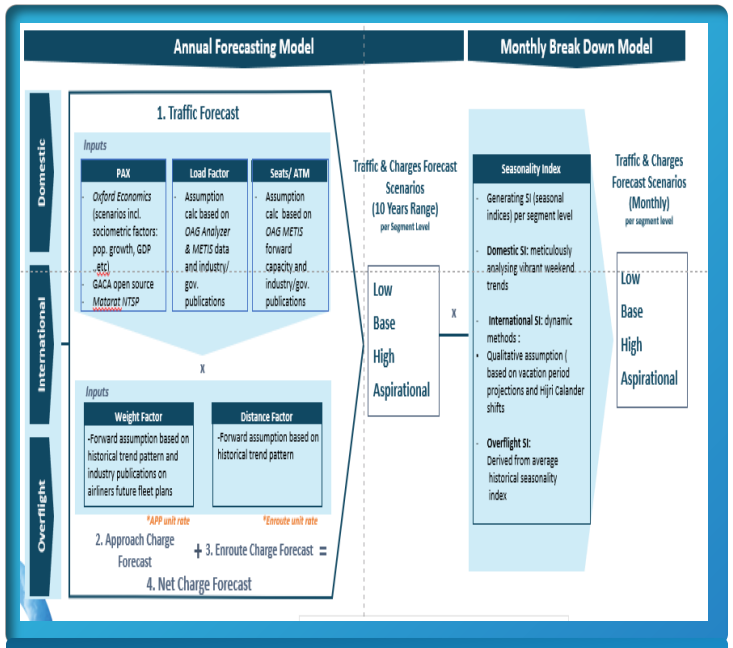
- % Departure Punctiallity
- % Arrival Punctuality
- # Taxi-Out Additional Time
- # Taxi-In Additional Time

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics use-cases | Predictable demand



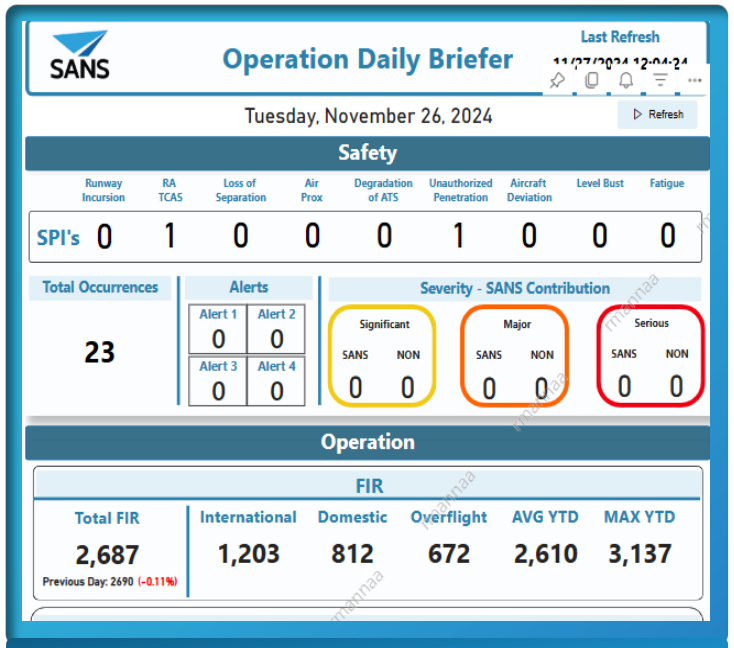
Traffic and Service Unit (SU) Forecast Framework



Load Factor | PAX | Seat/Aircafts

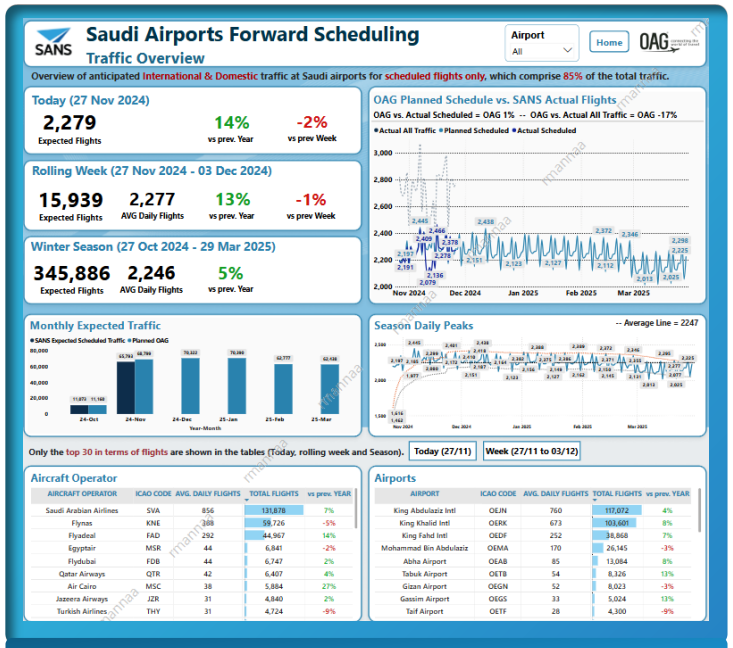
- # Yearly Traffic and SU / Segment 10 Years Range
- # Monthly Traffic and SU per Segment
- Load Factor PAX and Capacity Projections

Operation Daily Breifer



- # Daily Flights and Movements
- Heatmap Traffic Hourly
- Runway Throughput

Rostering and Planning

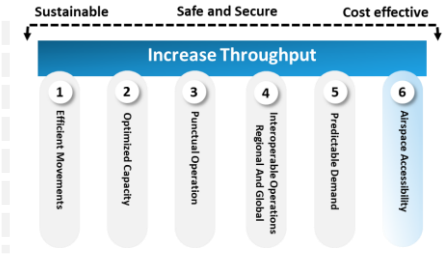


OAG Forward Capacity | Seasonal Schedules

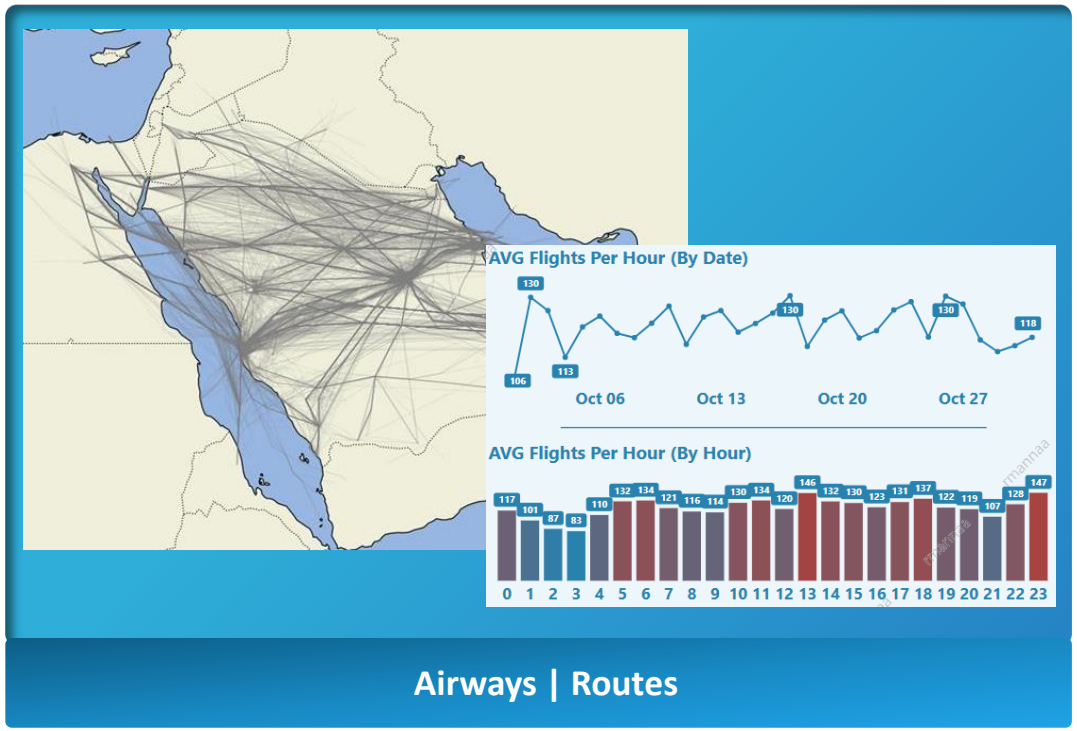
- # Expected Daily Peaks
- % Planned vs. Actual Traffic

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics Use-cases | Airspace Accessibility



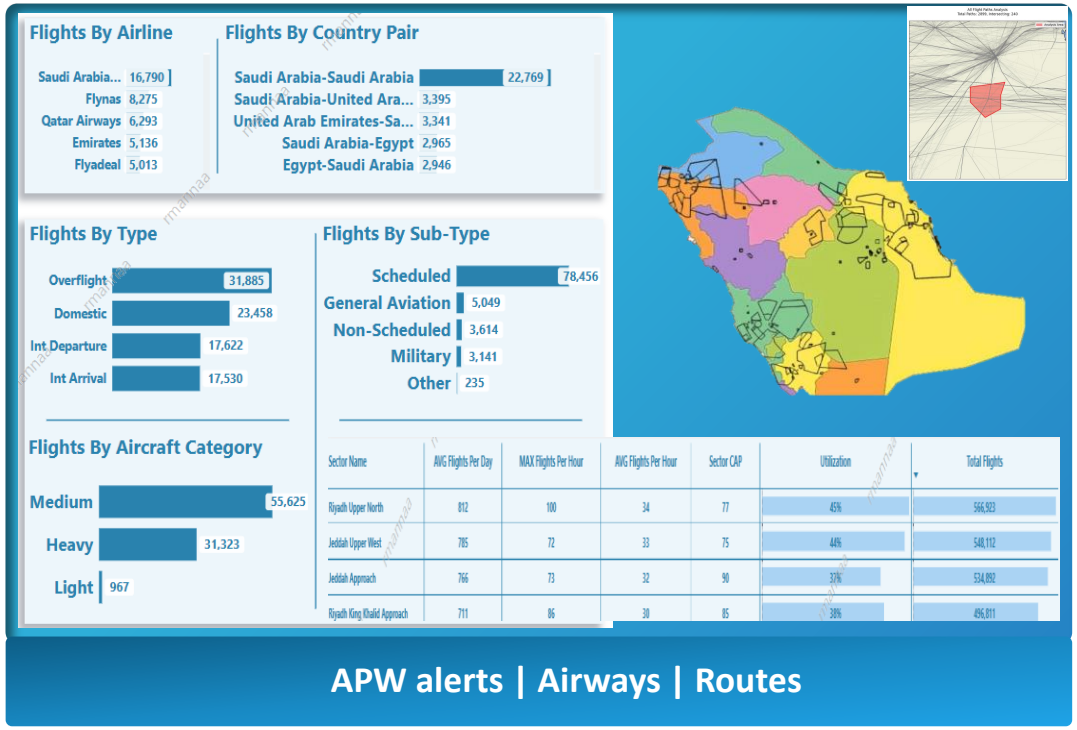
Flight Path Maps



Airways | Routes

- Flight Path Analysis
- Routes and Airways Utilization

Restricted Areas Proximity

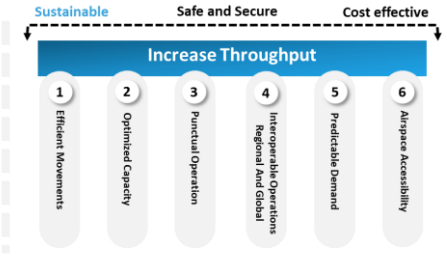


APW alerts | Airways | Routes

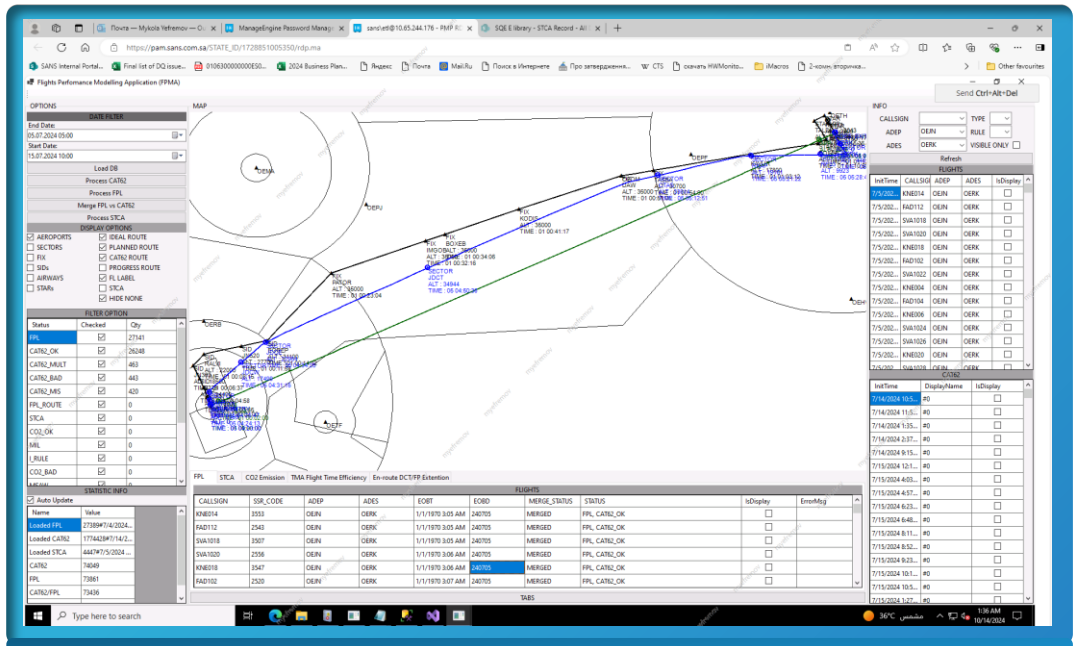
- Unauthorized Penetration Area
- Operational Sectors Utilization

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics use-cases | Sustainability



FPMA CO2



Saudi FIR

- 4D Trajectory-Based Calculations
- Sectors Based CO2 and Fuel Burns

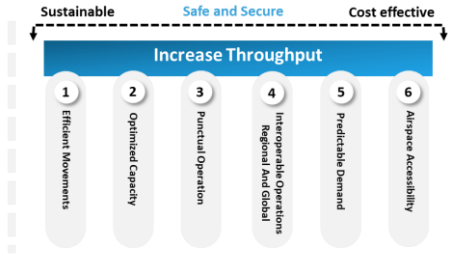
CO2 and Fuel Burn Dashboard

CO2 | Fuel Burn | Flight Phases | Aircrafts

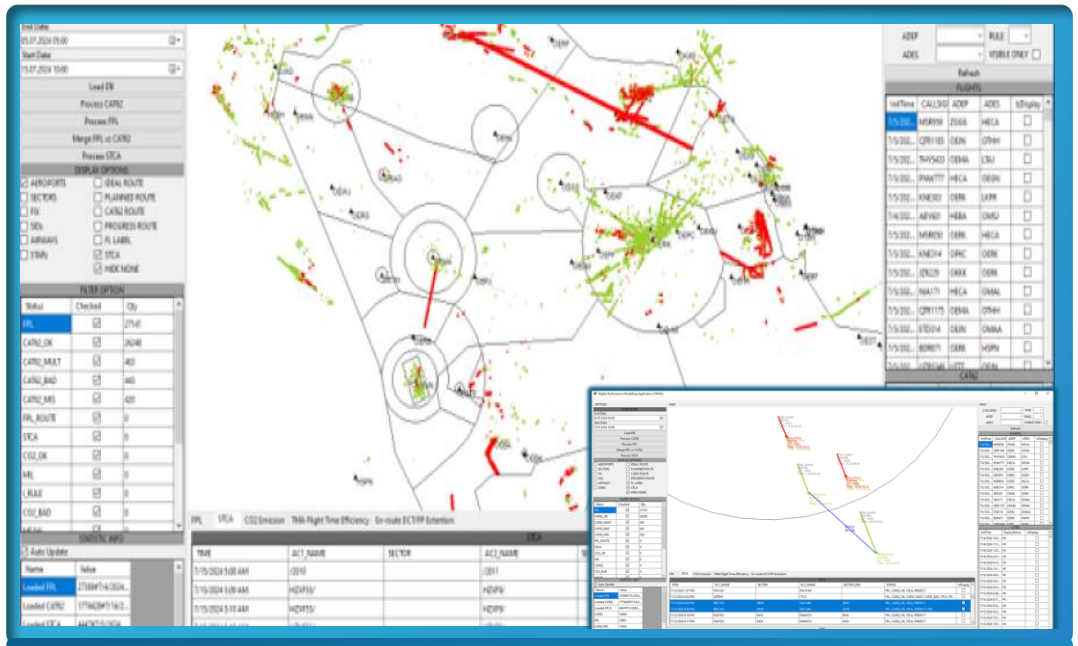
- Percentage of Consumed CO2 Emissions
- Segments-Based CO2 and Fuel Consumption
- Average Flight and Emission Index

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics Use-cases | Safety & Security



FPMA SNET



Predictions | Infringements

- Safety NET Alerts
- MSAW | STCA Predictions and Infringements Alerts
- Alerts Duration and levels

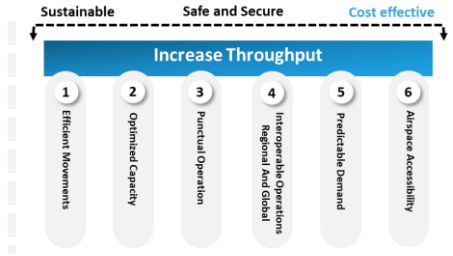
Safety and Security Dashboards

HSSE | SQC | OSA | OSQ |

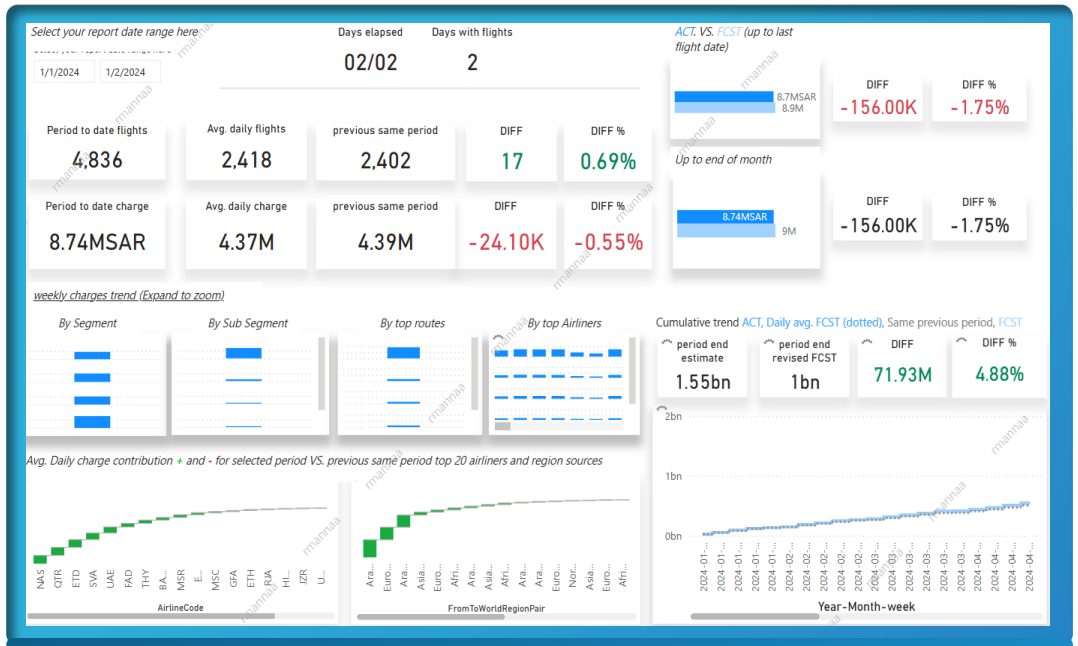
- Mandatory Occurrence Reports
- Investigation| Safety Recommendations
- Safety Reporting Culture

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Analytics Use-cases | Cost Effectiveness



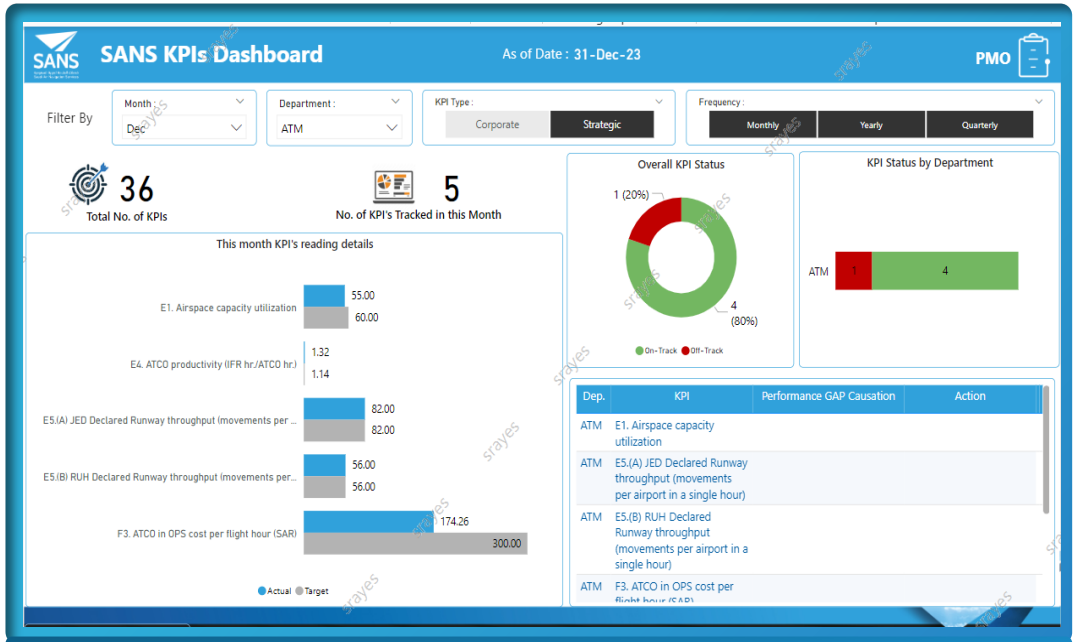
Month To Date Billing Dashboard



Weekly Service Units | Forecast | Budget

- Weekly Service Units Updates
- % Actual vs. Budgeted Service Units

Cost Effectiveness KPI



ATCO | Cost per Flight Hour

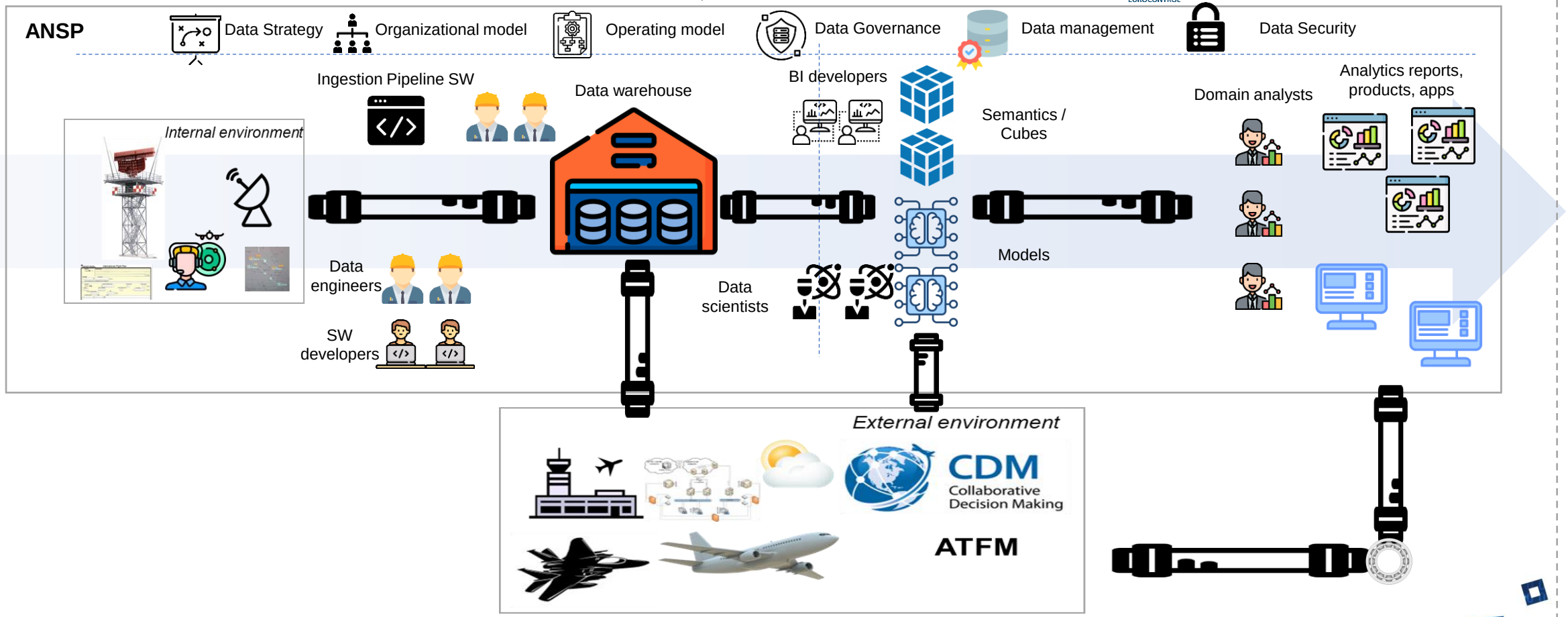
- ATCO in OPS Cost per Flight Hour
- ATCO Productivity per Hour

*** Exhibits from SANS CO products and tools; Exhibited data might be sampled or not masked/randomized*

Backbone For Successful Analytics Function In ANSP

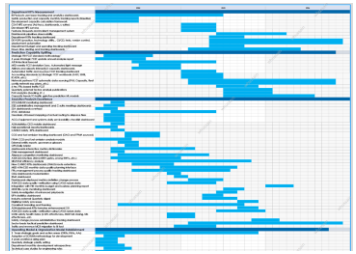
Governing and best practices

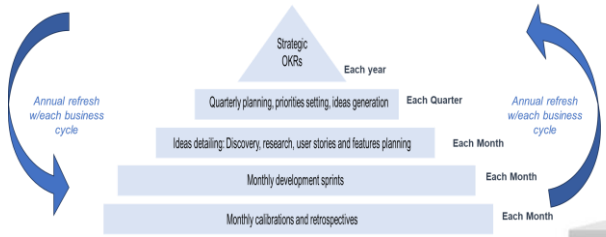
ICAO GACA CANSO EUROCONTROL IATA

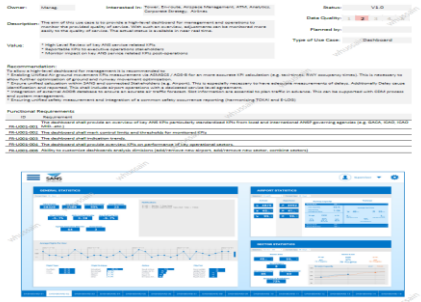


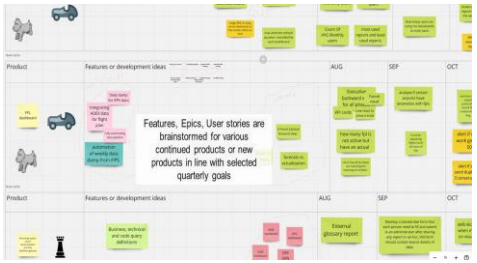
** Exhibits based on author assumptions

Backbone for Analytics | Strategy









Sprints plans, outcome roadmaps, feedback interfaces

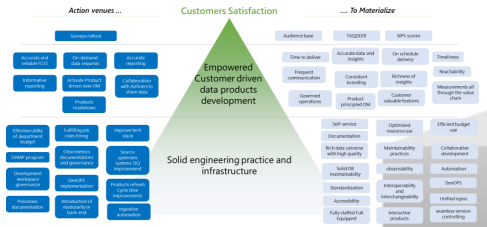
Use-cases, Epics, Users stories, Action agenda

End-user CSAT	
Customer NPS	+7 avg.
TAQDEER	1 silver of gold per cycle
Active user base	50 users
MoM growth in active users	+1 per month
FCST accuracy VS. budgeted	<+- 5% deviation

Efficient budgeting	
Hiring fulfillment	100% in cycle
Projects SCH deviation	<=20% from plan
Spending deviation	<=10% deficit
Budget utilization	>= 60% of cycle ask

Efficient production	
Features growth	10% YoY in cycle
Products per FTE	= 1 per FTE in cycle
Monitoring metrics active	<= 10 metrics reported
Load to capacity ratio	100% per sprint
Developer NPS	+7 avg.

Tech innovation	
Down-time	10% YoY in cycle
Mean time to recover	<= 8 hrs.
% Ad-hocs per sprint	<= 50%
Artifacts aging	<= 10 days
Data platform progress	Phase I and Phase II completed



North star, OKRs, KRAs

Excellence in development

delivering high-quality, scalable software through clean code, thorough testing, agile practices, CI/CD, and effective collaboration.

Themes: Agility, reliability, CoE

+

Excellence in production

Optimizing for efficiency, productivity, and alignment of development operations with strategic goals while adhering to budget and schedule constraints.

Themes: Production management

=

Satisfactory business outcomes

Positive Satisfaction and engagement of both staff and stakeholders, affirmed by recognition and products user base growth.

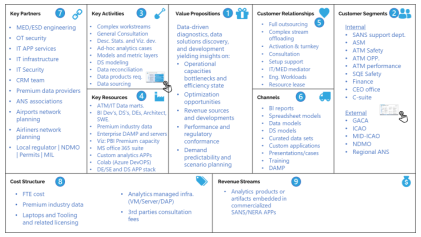
Themes: CSAT

Guiding principles, Desire states and inhibitors analysis, External environment analysis, industry partners/governors inputs/strategy

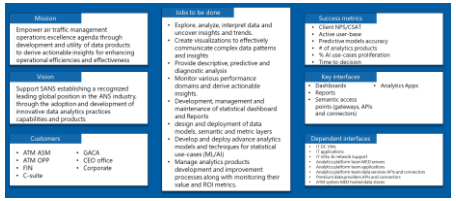
*** Exhibits based on author assumptions; some information presented is randomized or masked for illustration purposes only*

Backbone for Analytics | Operating Model & org. Model

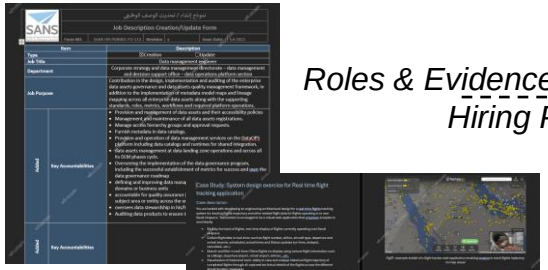
Service Model

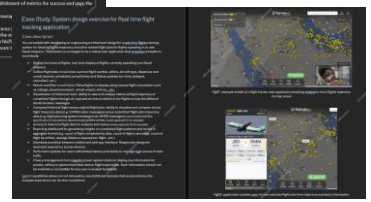


Charters & Missions

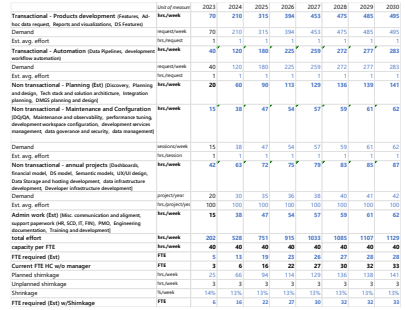


Roles & Evidence Based Hiring Process

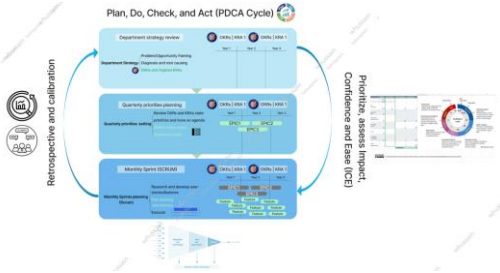




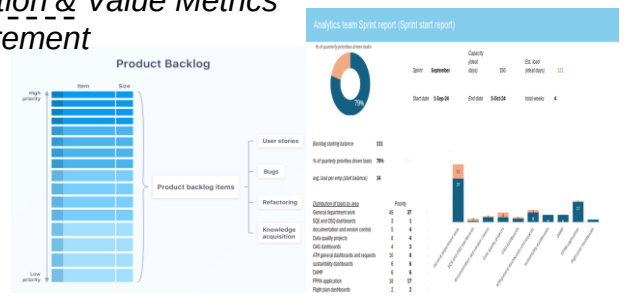
Org. Sizing Model



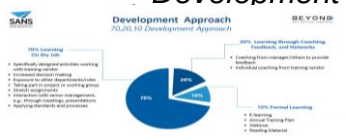
Strategy to Developing System



Production & Value Metrics Measurement



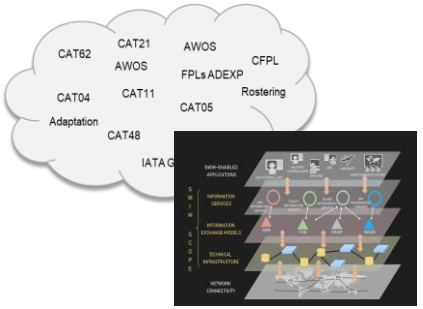
Training & Development



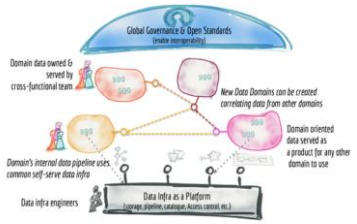
*** Exhibits based on author assumptions; some information presented is randomized or masked for illustration purposes only*

Backbone For Analytics | Data governance & Management

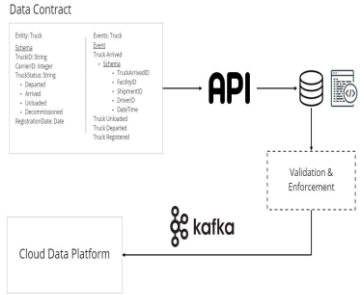
Availability & Integration



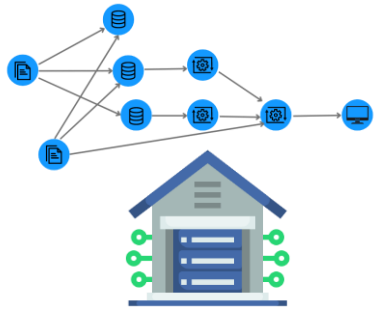
Domain Driven Stewardship



Data Contracts

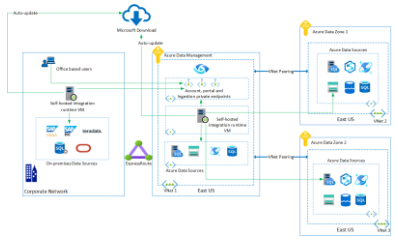


Meta Data Management

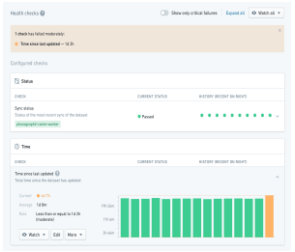


Continuous Data Quality

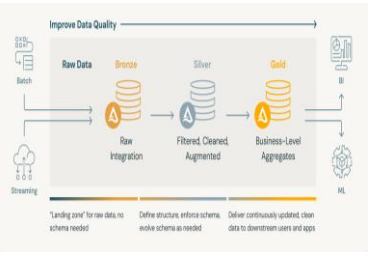
Security & Privacy



Health Checks

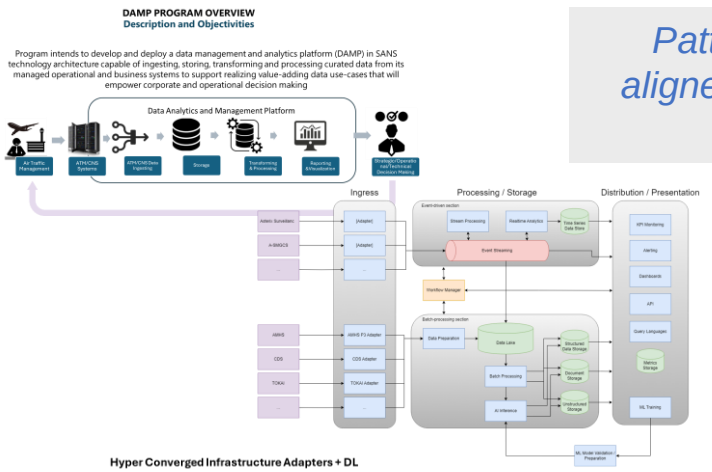


Curation & Abstraction

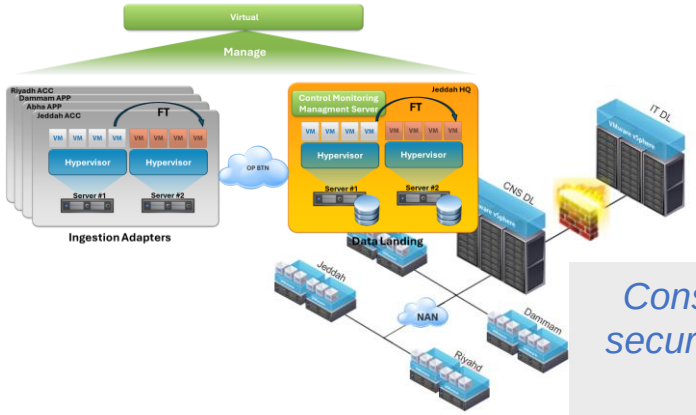


*** Exhibits based on author assumptions; some information presented is randomized or masked for illustration purposes only; courtesy of SWIMREFERENCE, dataproducts.substack.com, Martinfowler.com; Palantir:; Deltalake; courtesy of Microsoft publications*

Backbone for Analytics | Tech Stack



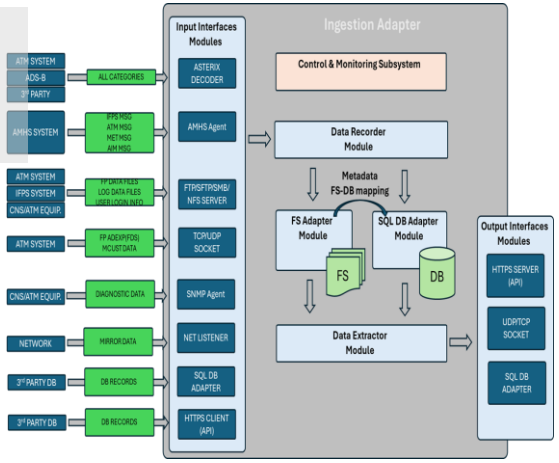
Hyper Converged Infrastructure Adapters + DL



Ingestion Adapters

Pattern should be aligned with business strategy

Universal standards interfaces/microservices



Consider decoupling, security and separation of concern

Analysed and informed decision… open source, low code, self service

*** Exhibits based on author assumptions; some information presented is randomized or masked for illustration purposes only*

Backbone For Analytics | Collaboration With Regional & Global Partner

Data point	Description
FPL activation	Flight plan activation by ATC
CTOT	Calculated take-off time
Departure time	Actual time of aircraft departure.
FIR entry time	Time aircraft enters a Flight Information Region.
Final approach	Last segment of flight before landing.
ALDT	Actual landing time.
Taxi in	Time from landing to gate arrival.
AGHT	Actual ground handling time.
AIBT	Actual in-block time
TOBT	Target off-block time
TSAT	Target start-up approval time
ARDT	Actual ready time.
ASRT	Actual ready time.
ASAT	Actual start-up approval time.
AOBT	Actual off-block time
MTTT	Minimum turnaround time.
TAXI Out	Time from gate departure to take-off.
ATOT	Actual take-off time.
EXOT	Estimated taxi-out time.
AXOT	Actual taxi-out time.
TTOT	Target take-off time.
EIBT	Estimated in-block time.
EOBT	Estimated off-block time.
EIBT	Estimated in-block time.
SIBT	Scheduled in-block time.
SOBT	Scheduled off-block time.
SIDT	Scheduled in-door time.
AIDT	Actual in-door time.

ATFM Operational Phases

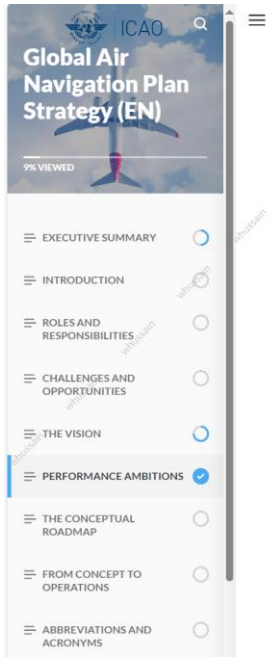
Five ATFM Operational Phases

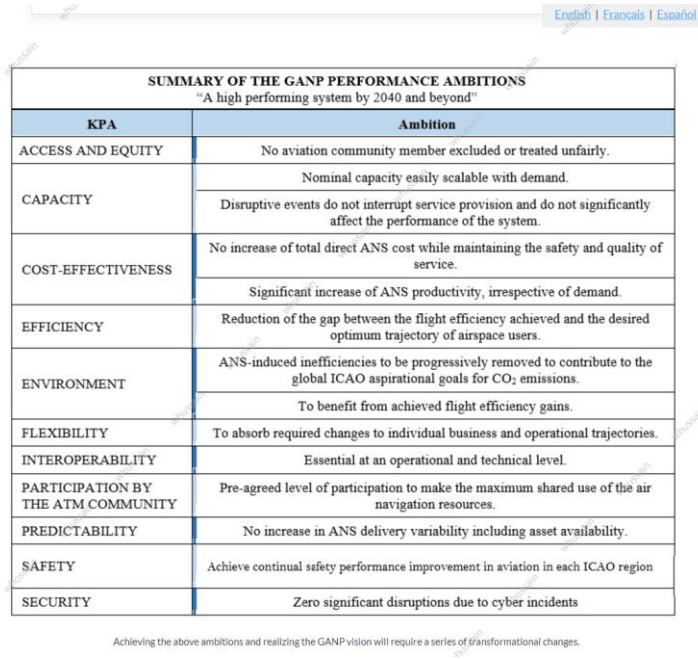
Time →

	ATM Planning	Strategic	Pre-Tactical	Tactical	Post Operations
Time Frame	Continual	Six month to two days prior	One day prior	Day of operation	Subsequent to operations
ATFM Role	Strategic long term planning	Demand capacity planning	ATFM daily coordination and next day planning	Tactical ATFM	Post-operation analysis
ATC Role	Improve procedures, sectorisation, staffing, technologies	Event planning, technology training and implementation	Input on staffing, equipment outage, weather impacts	Input as capacity changes, ensure safety	Input on results of demand capacity balance plan

*** Exhibits based on author assumptions; Courtesy of CANSO Publications; Metrics are provided for illustration purposes only*

Backbone for Analytics | International best practices

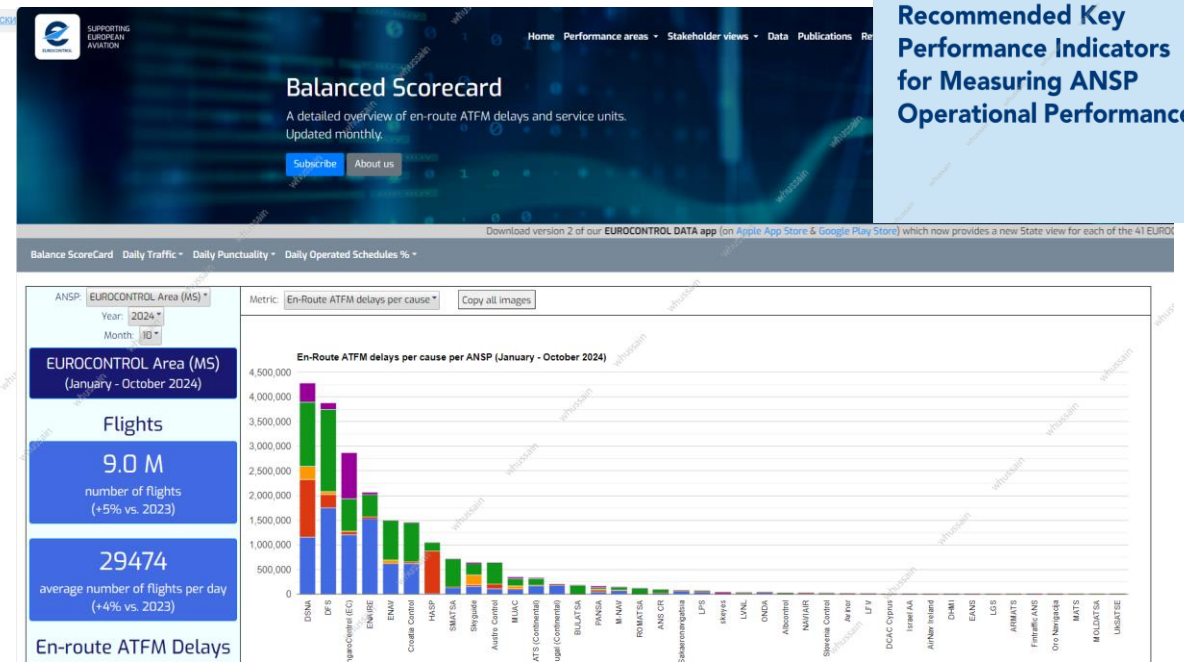




SUMMARY OF THE GANP PERFORMANCE AMBITIONS
"A high performing system by 2040 and beyond"

KPA	Ambition
ACCESS AND EQUITY	No aviation community member excluded or treated unfairly.
CAPACITY	Nominal capacity easily scalable with demand.
	Disruptive events do not interrupt service provision and do not significantly affect the performance of the system.
COST-EFFECTIVENESS	No increase of total direct ANS cost while maintaining the safety and quality of service.
	Significant increase of ANS productivity, irrespective of demand.
EFFICIENCY	Reduction of the gap between the flight efficiency achieved and the desired optimum trajectory of airspace users.
ENVIRONMENT	ANS-induced inefficiencies to be progressively removed to contribute to the global ICAO aspirational goals for CO_2 emissions.
	To benefit from achieved flight efficiency gains.
FLEXIBILITY	To absorb required changes to individual business and operational trajectories.
INTEROPERABILITY	Essential at an operational and technical level.
PARTICIPATION BY THE ATM COMMUNITY	Pre-agreed level of participation to make the maximum shared use of the air navigation resources.
PREDICTABILITY	No increase in ANS delivery variability including asset availability.
SAFETY	Achieve continual safety performance improvement in aviation in each ICAO region
SECURITY	Zero significant disruptions due to cyber incidents

Achieving the above ambitions and realizing the GANP vision will require a series of transformational changes.



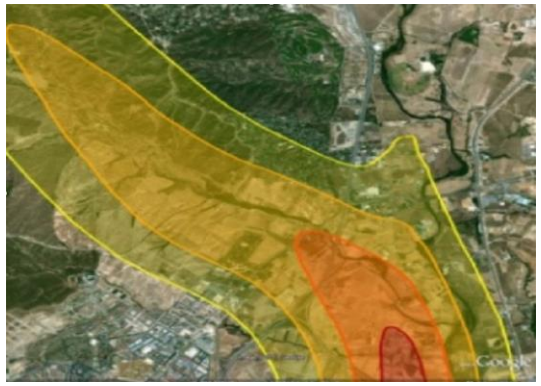
canso

Recommended Key Performance Indicators for Measuring ANSP Operational Performance

*** Courtesy of ICAO GANP; Courtesy of CANSO publications, Courtesy of Eurocontrol ANSPperformance dashboard*

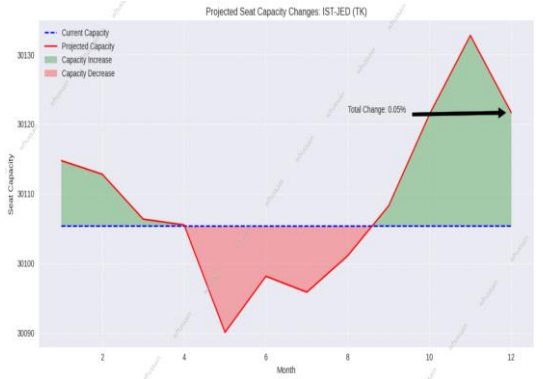
Future Endeavors

AI & ML use-cases in ANSP Analytics

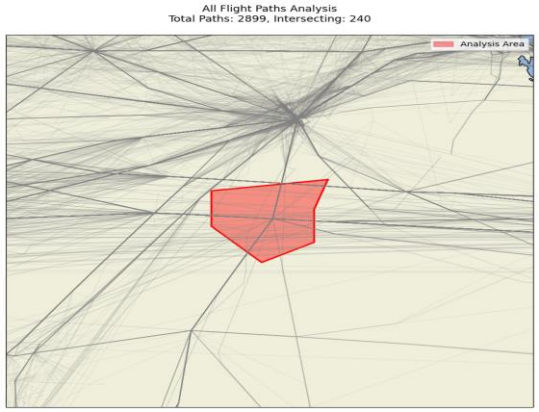


Noise profile optimization (flight trajectory optimization)

Prediction of expected actual 4D flight routes

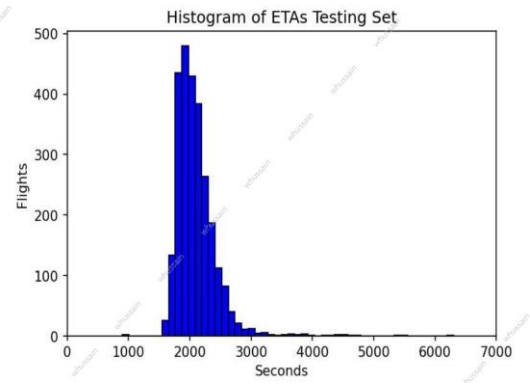


SCH forward capacity and demand realization prediction



Early prediction of APWs and restricted area penetration

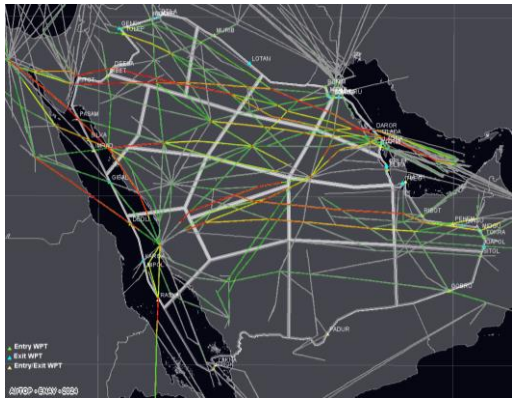
AI generated safety insights and analysis aids



ETD/ETA and Delay predication (strategic)

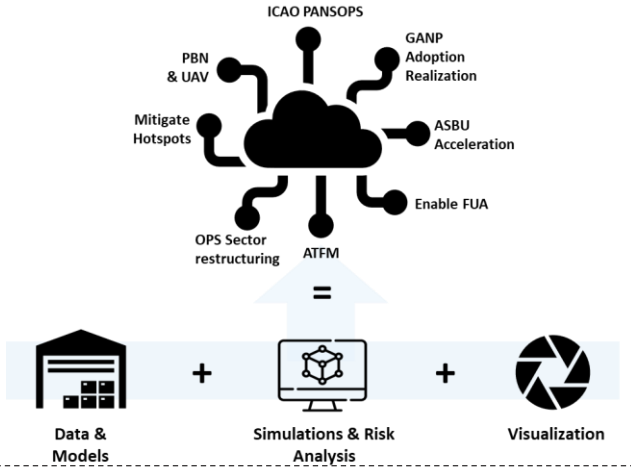
*** Courtesy of Eurocontrol publications; Courtesy of NASA publications; some exhibitions from SANS current workloads*

SANS CO Efforts To Re-design Saudi FIR Airspace | Project SFAC



The Civil Aviation Strategy is aiming to achieve and meet **KSA vision 2030** which has set target ambitions for air transport:

330M PAX **4.5 Tons of Air Cargo** **+250 destinations,**



Saudi **F**uture **A**irspace **C**oncept launched in partnership with *ENAV group* to re-design Saudi FIR airspace and route structure to increase airspace capacity, enhance flight efficiency, promote environmental sustainability, and bolster overall safety standards to accommodate targeted ambitions set.

1 Airspace Organization & Management

- New Integrated Airspace Design
- ATC Sectorization
- Free Route
- FUA
- Dynamic sectorization
- MSP
- Low IFR Network
- VFR Network and IFR implementation
- VLL
- RPAS
- HAO

2 Enhance Airport and TMA Operations

- Parallel Approaches – Simultaneous Departures
- HIRO
- RECAT
- TBS

3 Flight Trajectory Optimization

- ATFM (including AMAN-DMAN, A-CDM integration
- Advanced Traffic Separation Management
- PBN

4 Virtualization of Service Provision

- Virtual and remote ATS facilities
- Remote Towers Centre

SANS
خدمات الملاحة الجوية السعودية
Saudi Air Navigation Services

MANAGING SKIES
SECURING LIVES

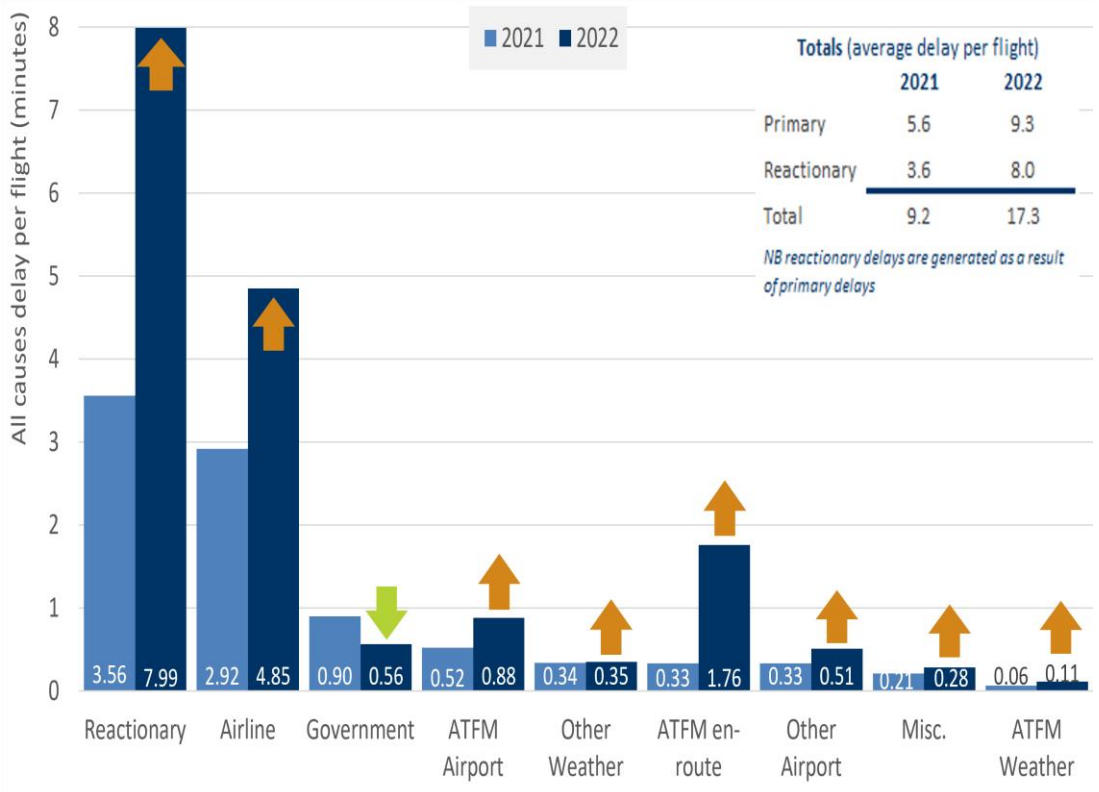
Closing..

BEYOND

Quote

The knowledge of anything, since all things have causes, is not acquired or complete unless it is known by its causes

Avicenna



*** Exhibit Courtesy of Eurocontrol reports*

Thank You

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Air Space Management: asabughallab@sans.com.sa

SANS CO Team

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MANAGING SKIES
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