SUPPORTING
EUROPEAN
AVIATION

EUROCONTROL NM CAPAN Methodology

Models to Determine Airspace Capacity

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CONSORTIUM COORDINATOR sesar DEPLOYMENT MANAGER
FOUNDING MEMBER sesar JOINT UNDERTAKING
NETWORK MANAGER

Determining Sector Capacity
EUROCONTROL CAPAN Methodology

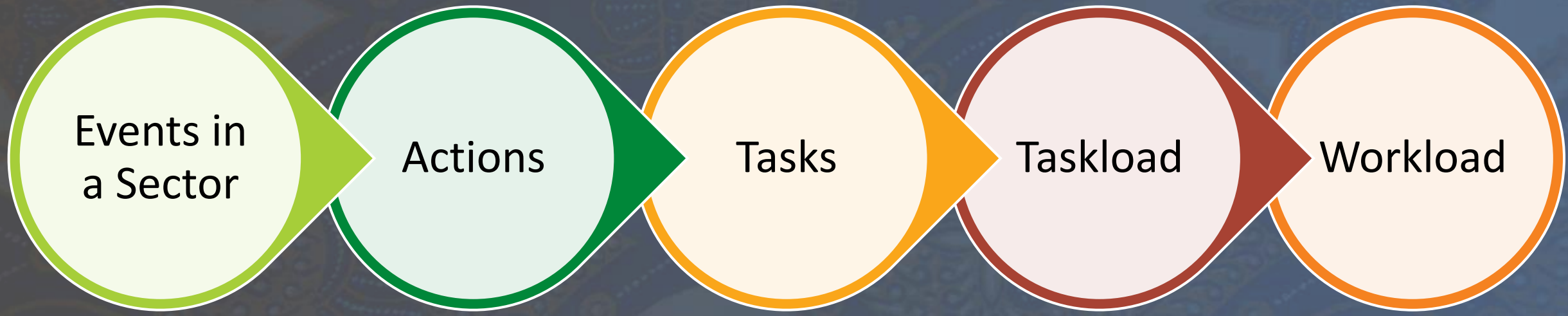
CAPAN

Simulation methodology

Controller workload

Sector Capacity

Fast-time Simulation in ATM



CAPAN
Main Principles

RCAPAN

70% workload threshold

Regression Analysis

Air Traffic Controllers

CAPAN
Main Principles

RCAPAN

- CAPAN dedicated version of RAMS (Reorganised ATC Mathematical Simulator owned by ISA Software)
- Fast-time simulator as others available on the market
- It allows flexible and detailed modeling of both ACC and TMA environment

CAPAN
Main Principles

70%

- **Theoretical Sector Capacity** is attained when controller **workload reaches 70%** of the absolute working time, i.e. 42 minutes in an hour
- **30%** represents tasks which cannot be captured by discrete events, e.g. a general monitoring of the radar screen or recuperation time
- 70% threshold has been assessed through a **process of fine-tuning** of the discrete event logic when the first CAPAN studies were carried out together with several Real-Time simulations

CAPAN Workload Thresholds

Threshold	Interpretation	Recorded Working Time in 1 hour
70 % or above	Overload	42 minutes and above
54 % - 69 %	Heavy Load	32 - 41 minutes
30 % - 53 %	Medium Load	18 - 31 minutes
18 % - 29%	Light Load	11 - 17 minutes
0 % - 17 %	Very Light Load	0 - 10 minutes

CAPAN
Main Principles

Regression Analysis

- Mathematical technique for data analysis
- Type of regression specifically chosen for CAPAN purposes and based on dependency between workload and sector traffic entry rates
- Used to average sector behaviour over the simulation period, generally 24 hours
- Used to perform workload and traffic analyses based on specific periods of the day, traffic flows, etc

CAPAN
Main Principles

Air Traffic Controllers

- Fundamental importance for the validation of the simulation scenarios
- Provide support to define actual flight routings, procedures, tasks, conflict detection and resolution logic and other simulation parameters
- Bridging the gap between taskload and workload measurement
- Generally working in a team throughout the study together with two CAPAN simulation experts
- At least two active controllers from every simulated unit

CAPAN Input Data

Traffic and Airspace Data

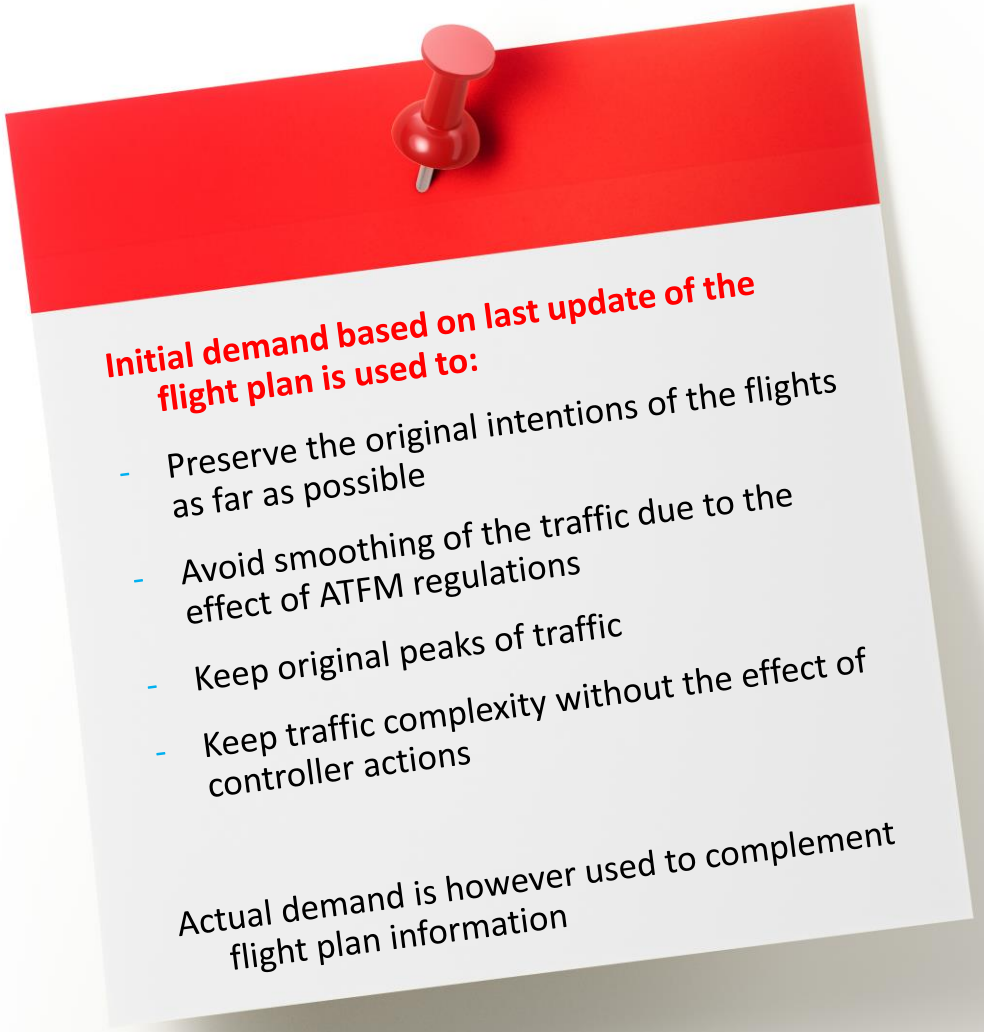
- **Traffic Data**
- **Aircraft Performance**
- **Airspace Structure**

ATC Model

- Simulation Parameters
- Conflict Detection/Resolution
- Air Traffic Controller tasks
- Sector manning

RCAPAN Simulation Engine

Traffic Data



Flight plans

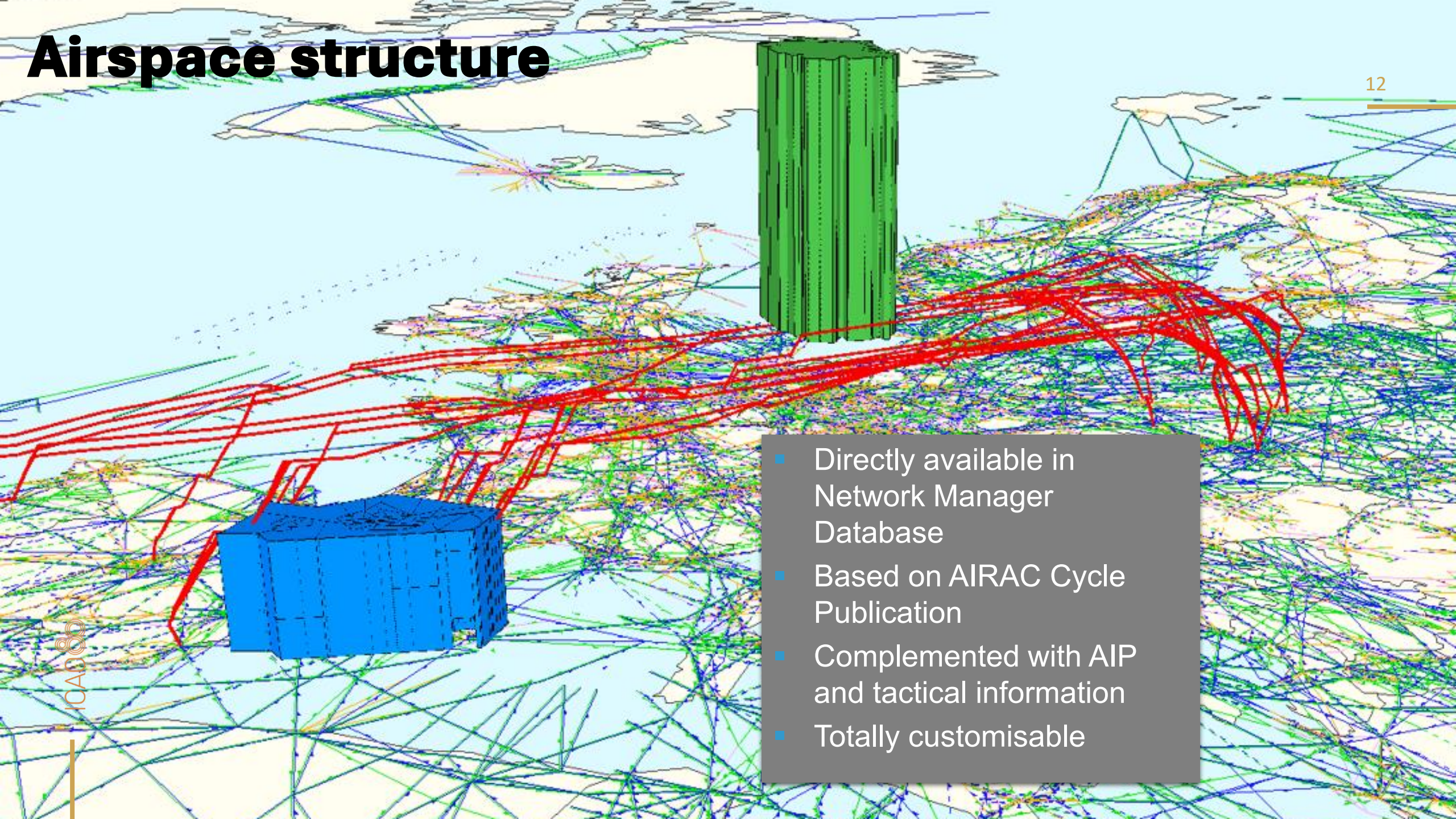
- Eurocontrol Network Manager's common archive DDR2 provides three types of traffic data:
  - Initial demand: the latest flight plan updates.
  - Regulated demand: flight plans impacted by flow restrictions.
  - Actual demand: flight profiles derived from coordinated position reports.
- Samples are selected to represent typical flows in the target area.
- The prepared traffic is then iterated multiple times to simulate various scenarios (e.g., entry times, performances).

Traffic Data

Aircraft Performance

- BADA: Base of Aircraft Data
- EUROCONTROL Database with nominal performances
- Fundamental for trajectory calculation
- Totally customisable to local procedures and company policies

Airspace structure



- Directly available in Network Manager Database
- Based on AIRAC Cycle Publication
- Complemented with AIP and tactical information
- Totally customisable

Simulation Parameters

- Several parameters required for fast-time simulation
- CAPAN tailored parameters for ACC and TMA environment
- Parameters to allow proper reproduction of the Procedures

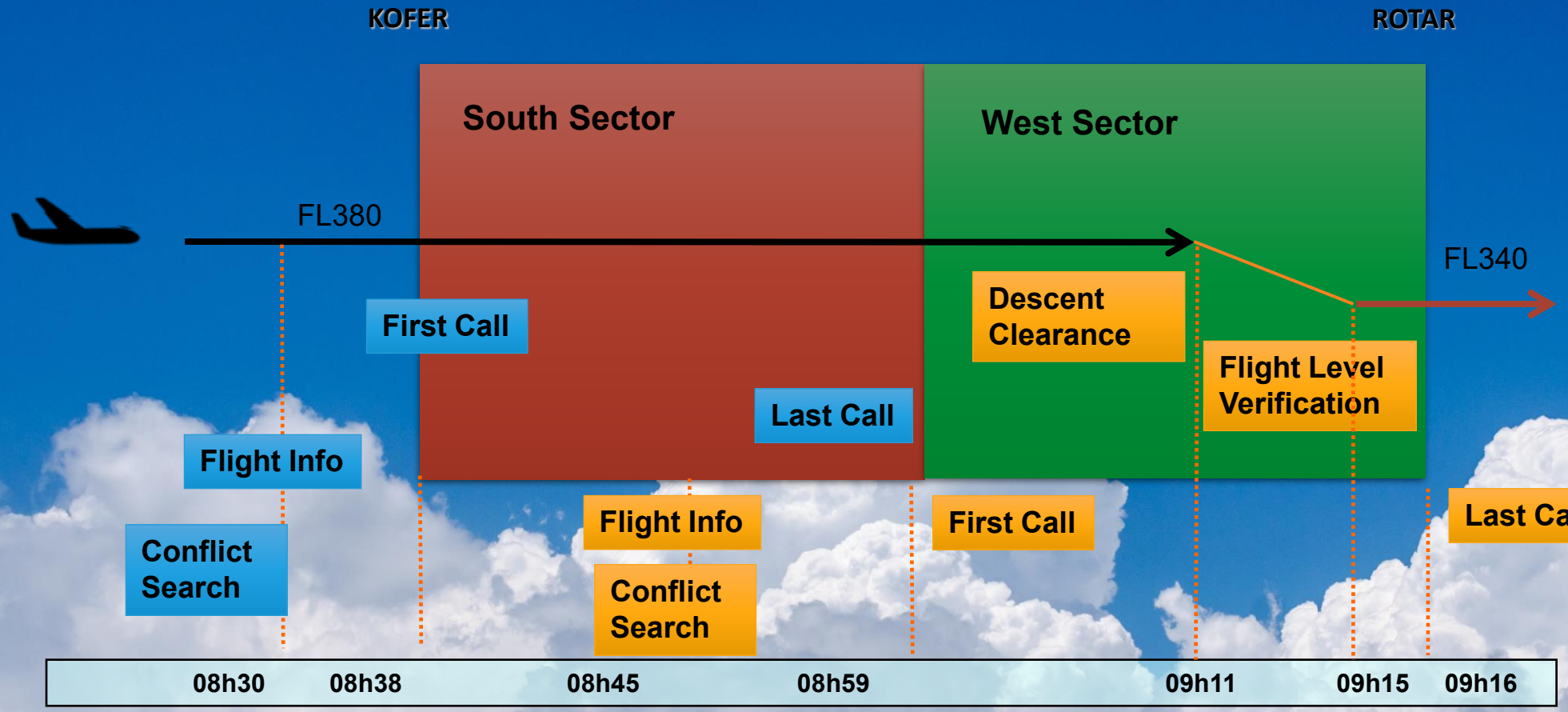
Logic for conflict detection/resolution mechanisms associated to separation minima

Controller Tasks and Sector Manning

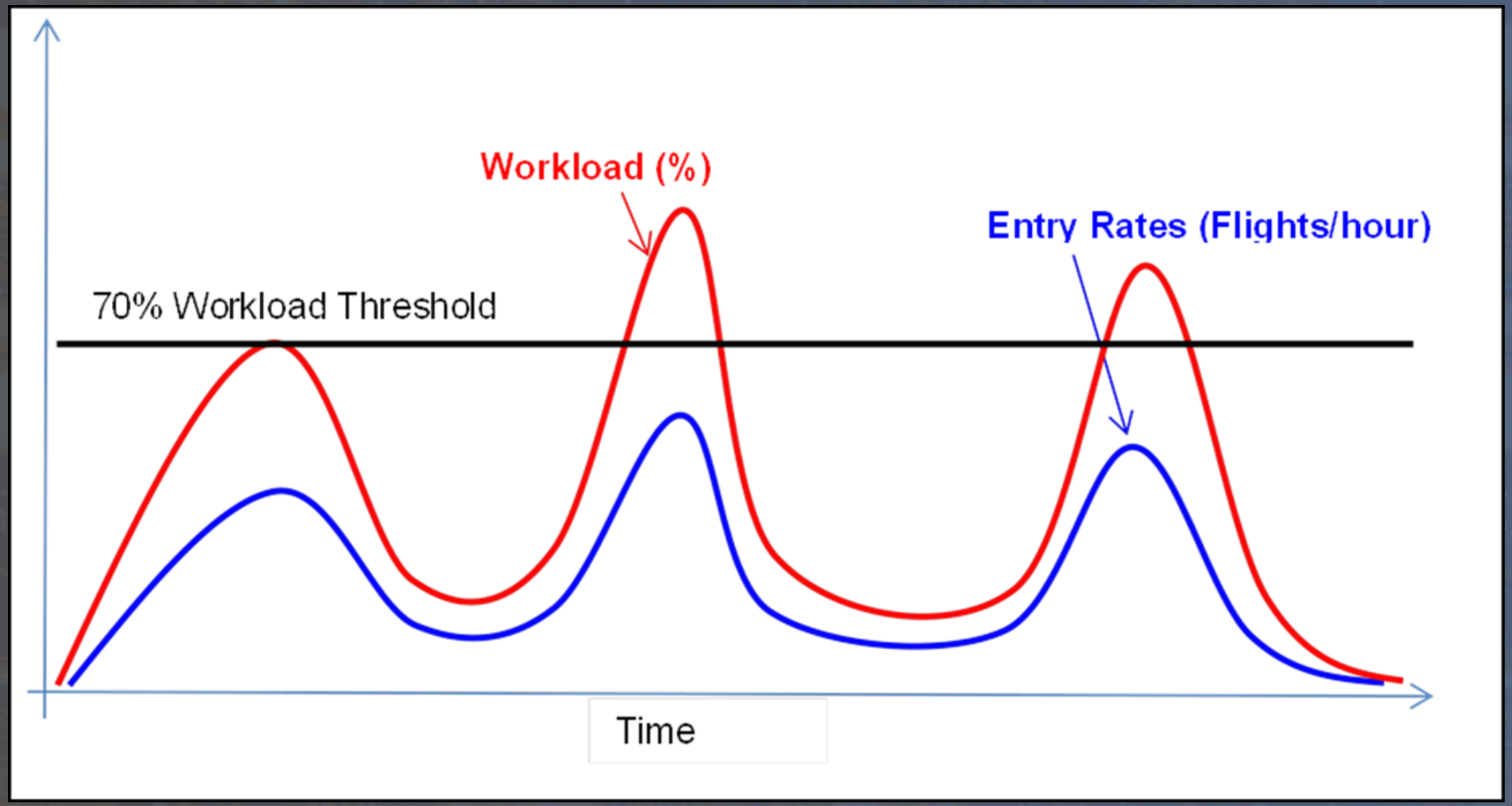
- **Standard model for controller tasks for both ACC and TMA environment**
- **Totally Customisable depending on system capabilities, specific procedures, separation minima, etc**
- **Divided into 5 main task categories:**
  1. Flight Data Management
  2. Conflict Search
  3. Coordination
  4. Standard Radio Telephony
  5. Radar
- **Applicable to single/double man operations, multi-sector planner, etc.**

Events and Tasks

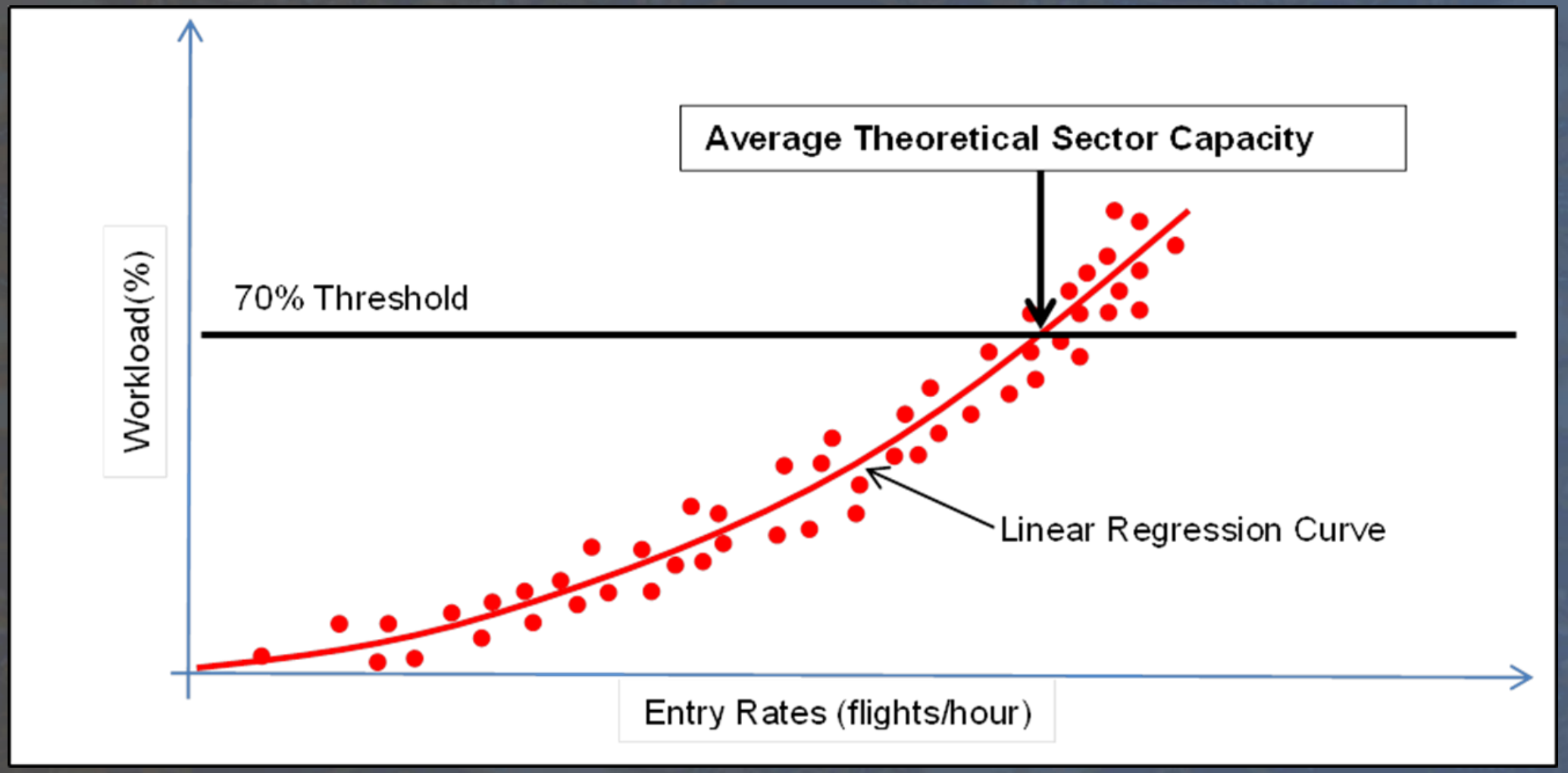
EZY770N A319 LGAV LIMC
EFL380 XFL340



Sector Behaviour



Calculation of Regression Capacity



CAPAN Workflow

- Observation of Operations
- Flight trajectories and procedures verification with ATCOs

DP1

Prototype model

- Amend/adapt flight routings
- Insert ATC procedures
- Standard ATCO tasks
- Standard simulation parameters
- Aircraft performances
- Test 4D flight profiles

- 4D Flight Profile Validation with ATCOs
- Verify and Customise ATCO tasks
- Fine-tune Simulation parameters
- Adapt aircraft performance

DP2

Simulation Scenario Consolidation

- Adapt and apply inputs from DP2
- Create agreed simulation scenarios
- Technical validation of simulation scenarios
- Results calculation

DP3

- ACC
  - **Preliminary results validation**
- TMA
  - Departure and arrival sequencing model validation
  - Simulation scenario **fine-tuning**

DP4

TMA only

- Preliminary results validation

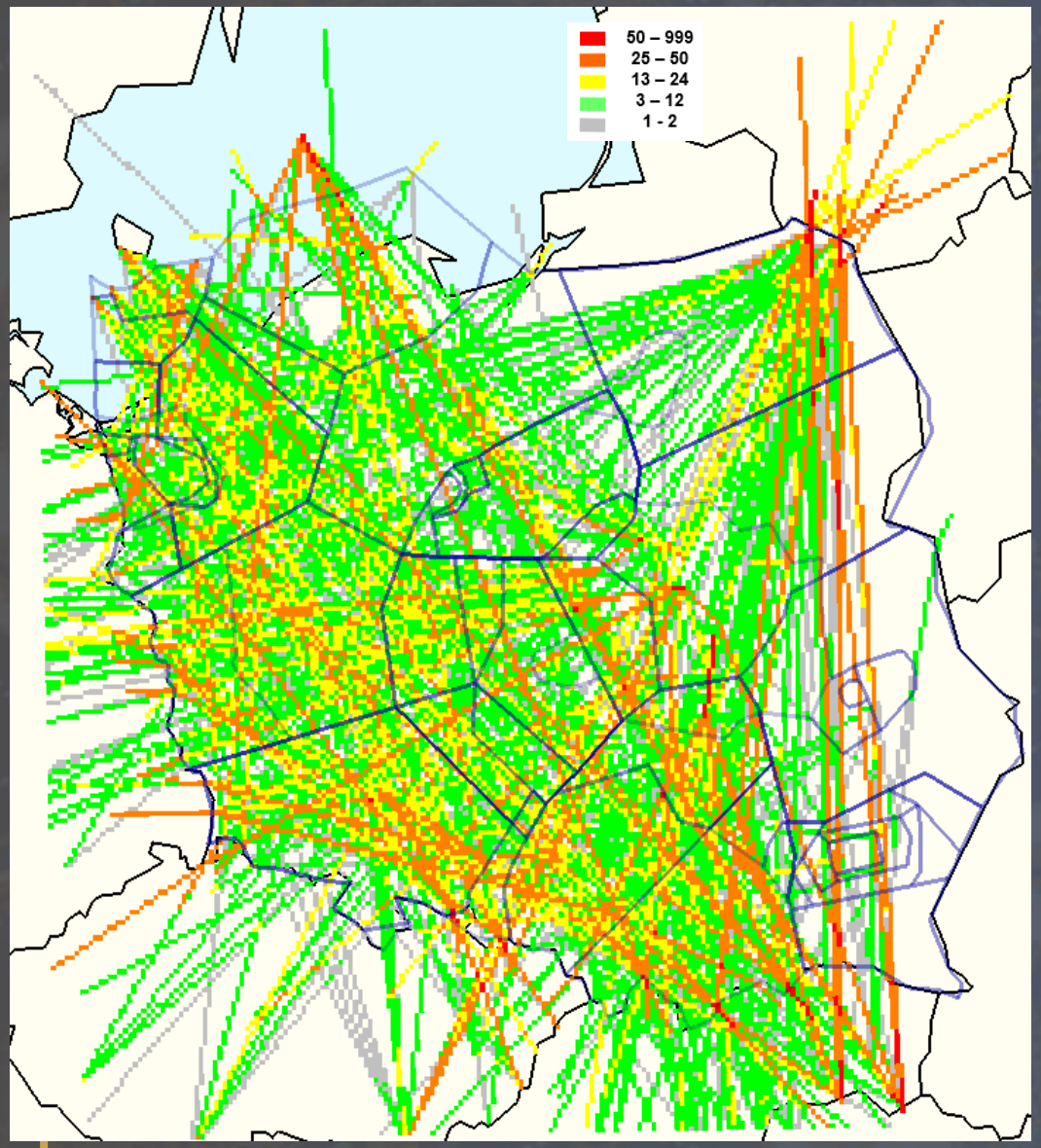
Simulation Scenario Finalisation

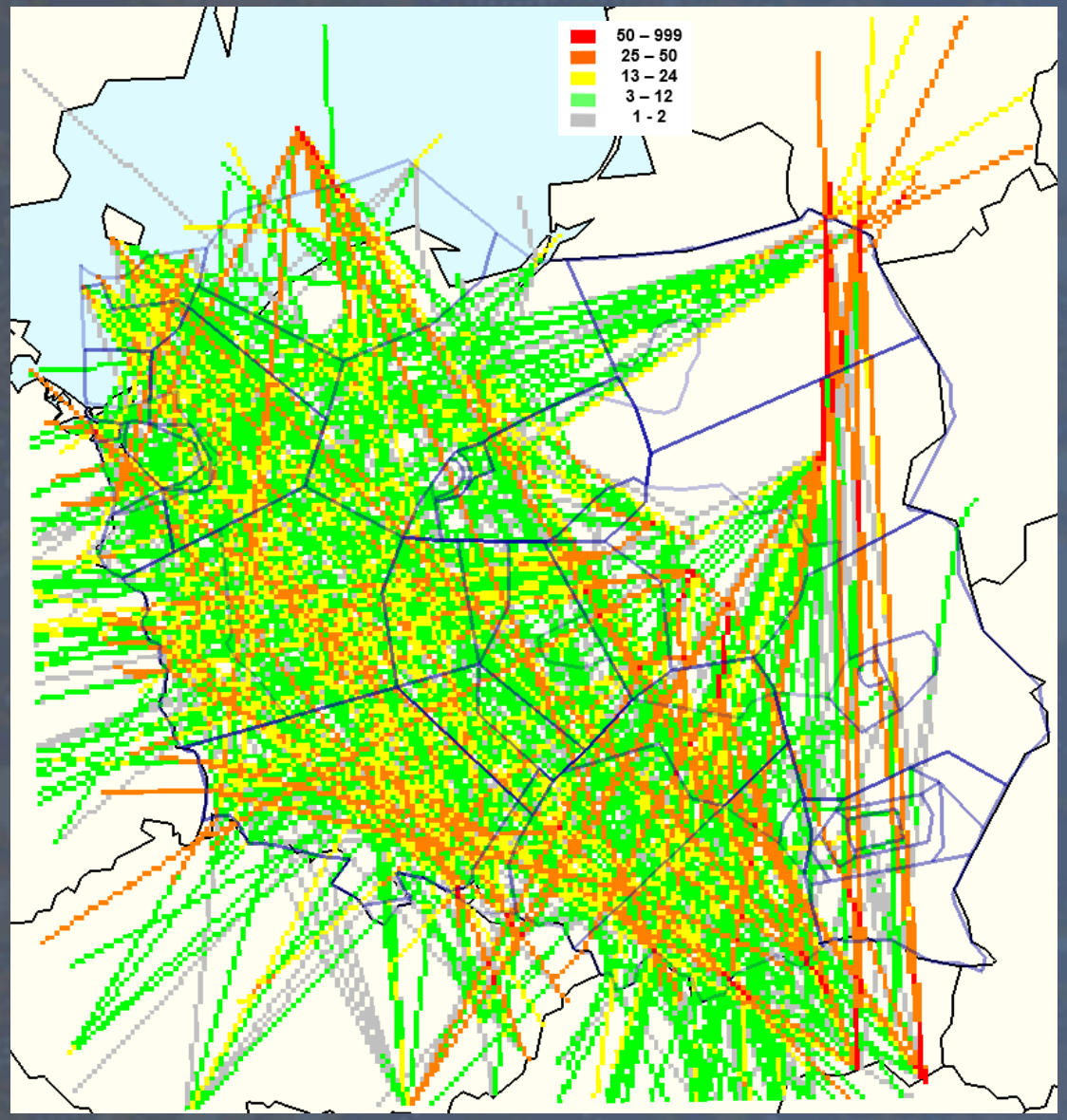
FINAL PRESENTATION

Working closely together with ATCOs

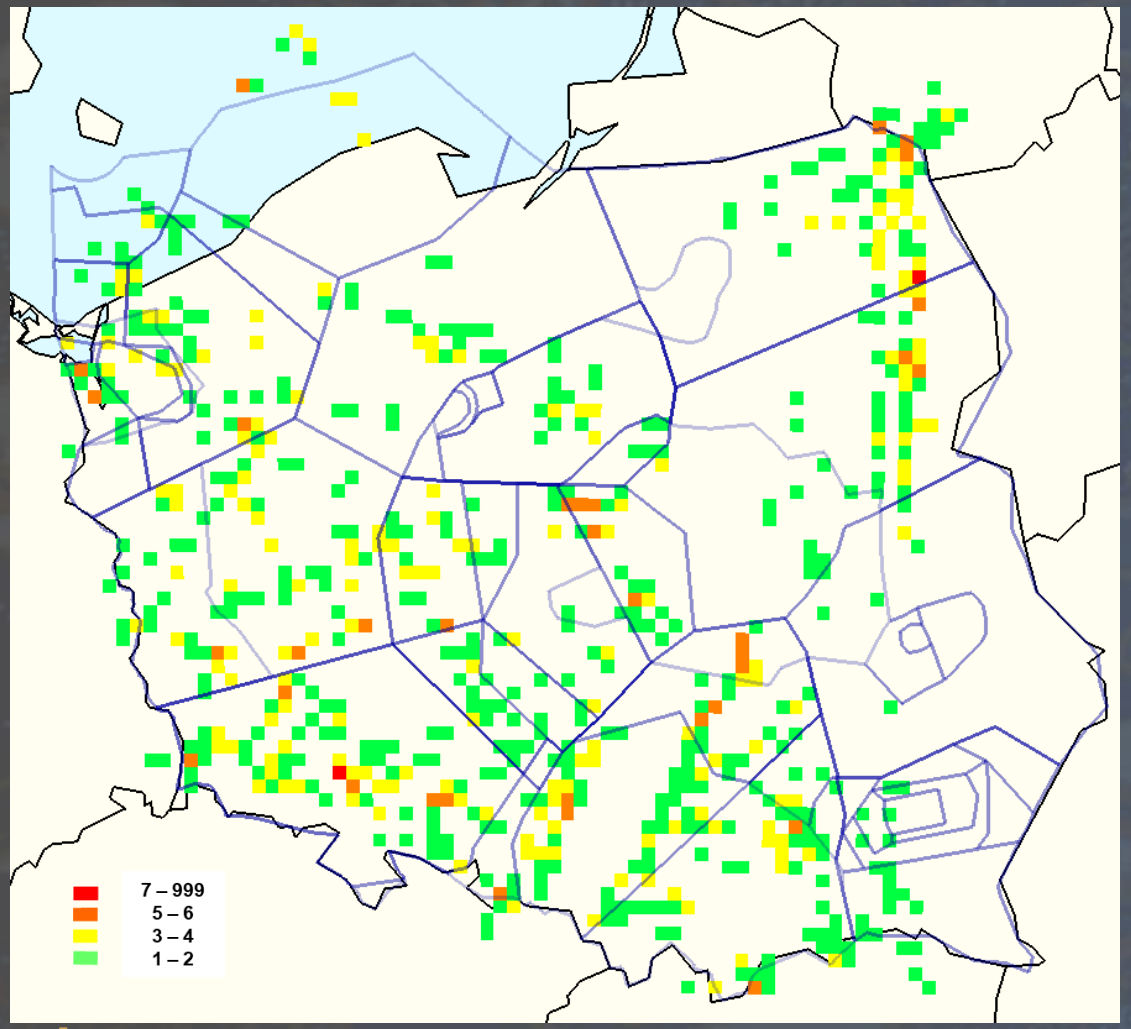
DP: Data Preparation Meeting

Traffic Density





Conflict Density



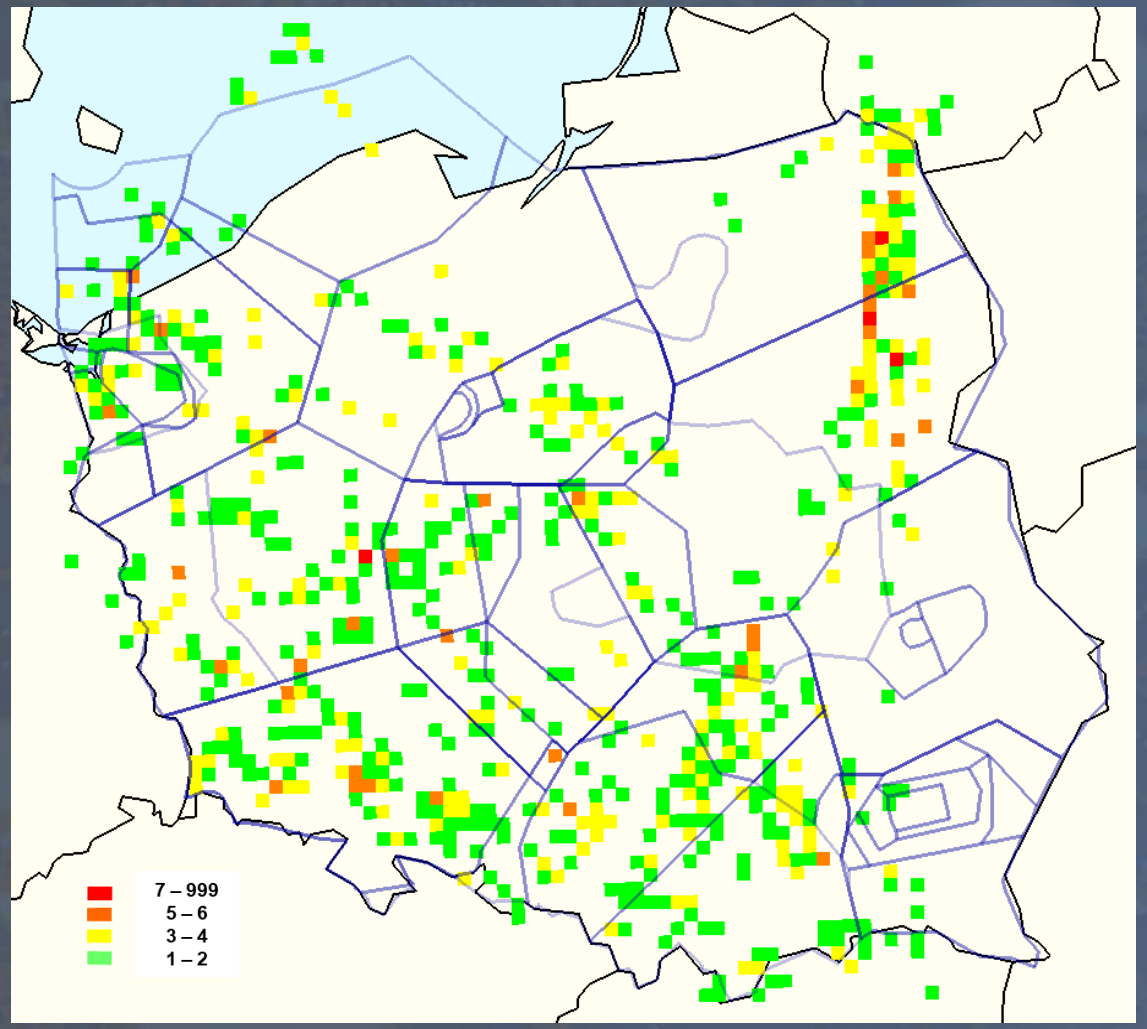
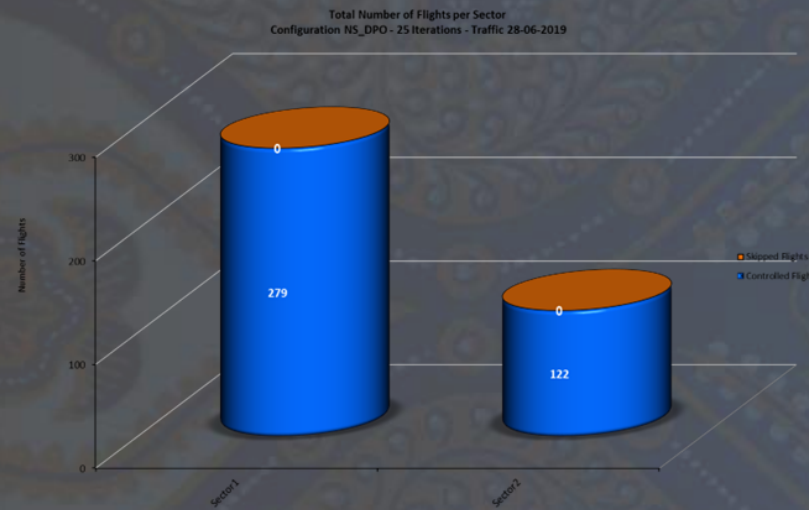
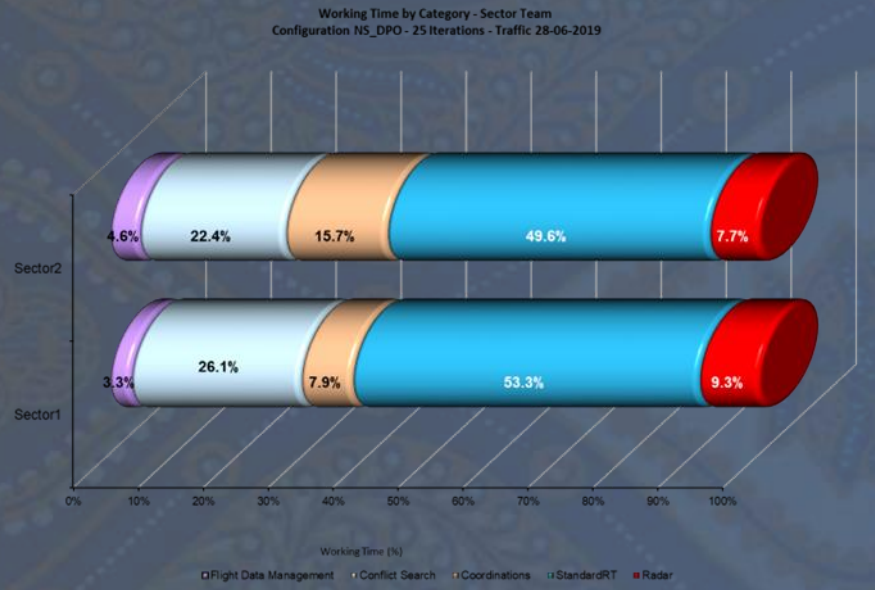
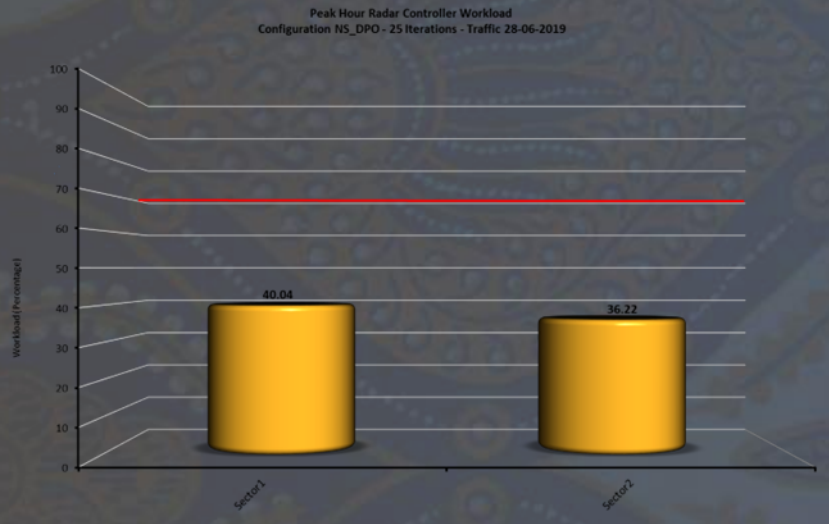


Chart Examples







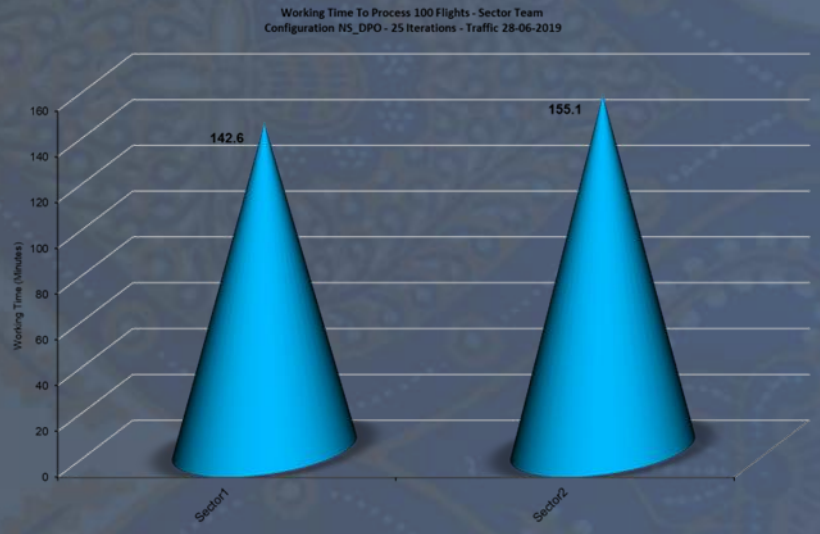


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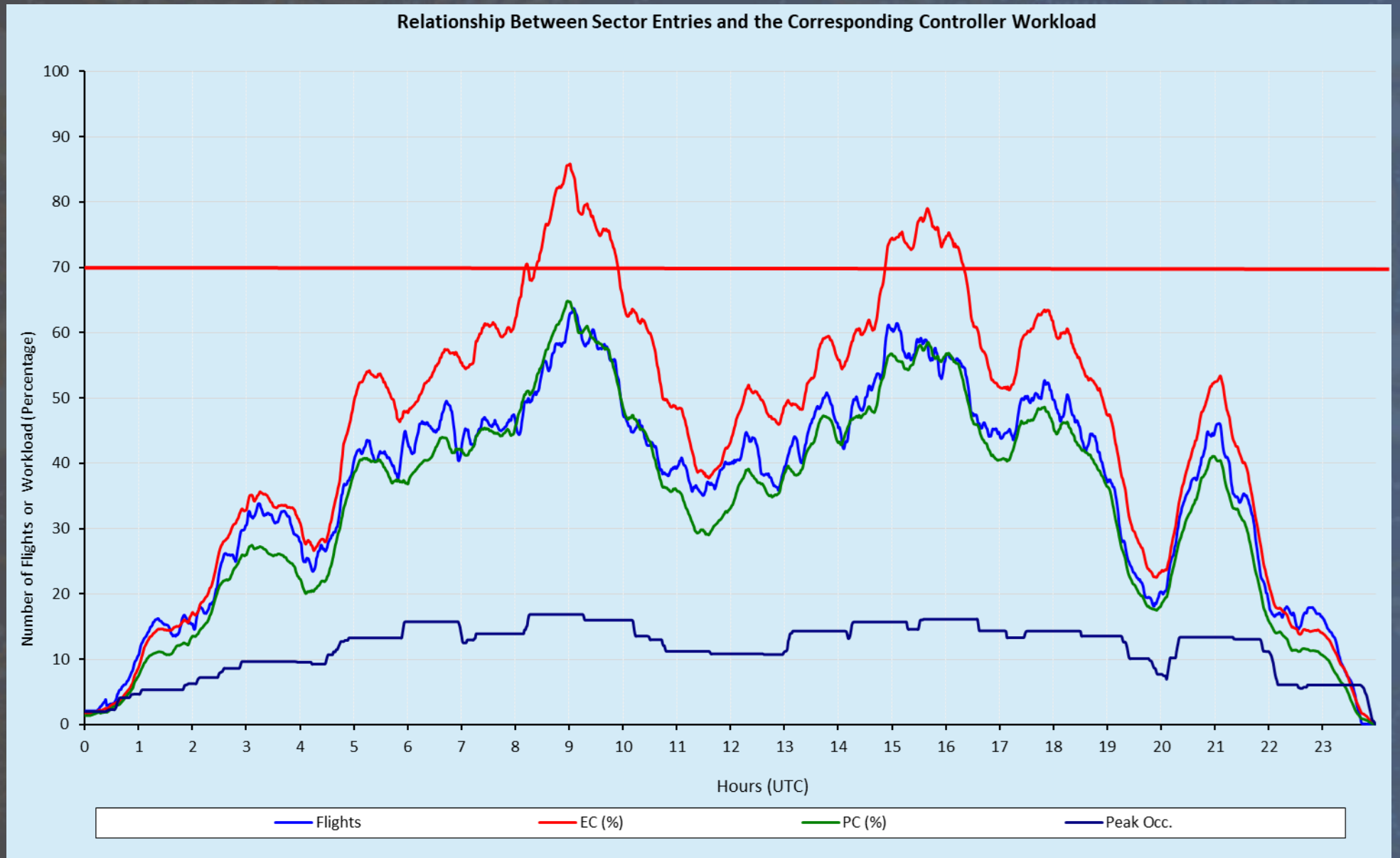
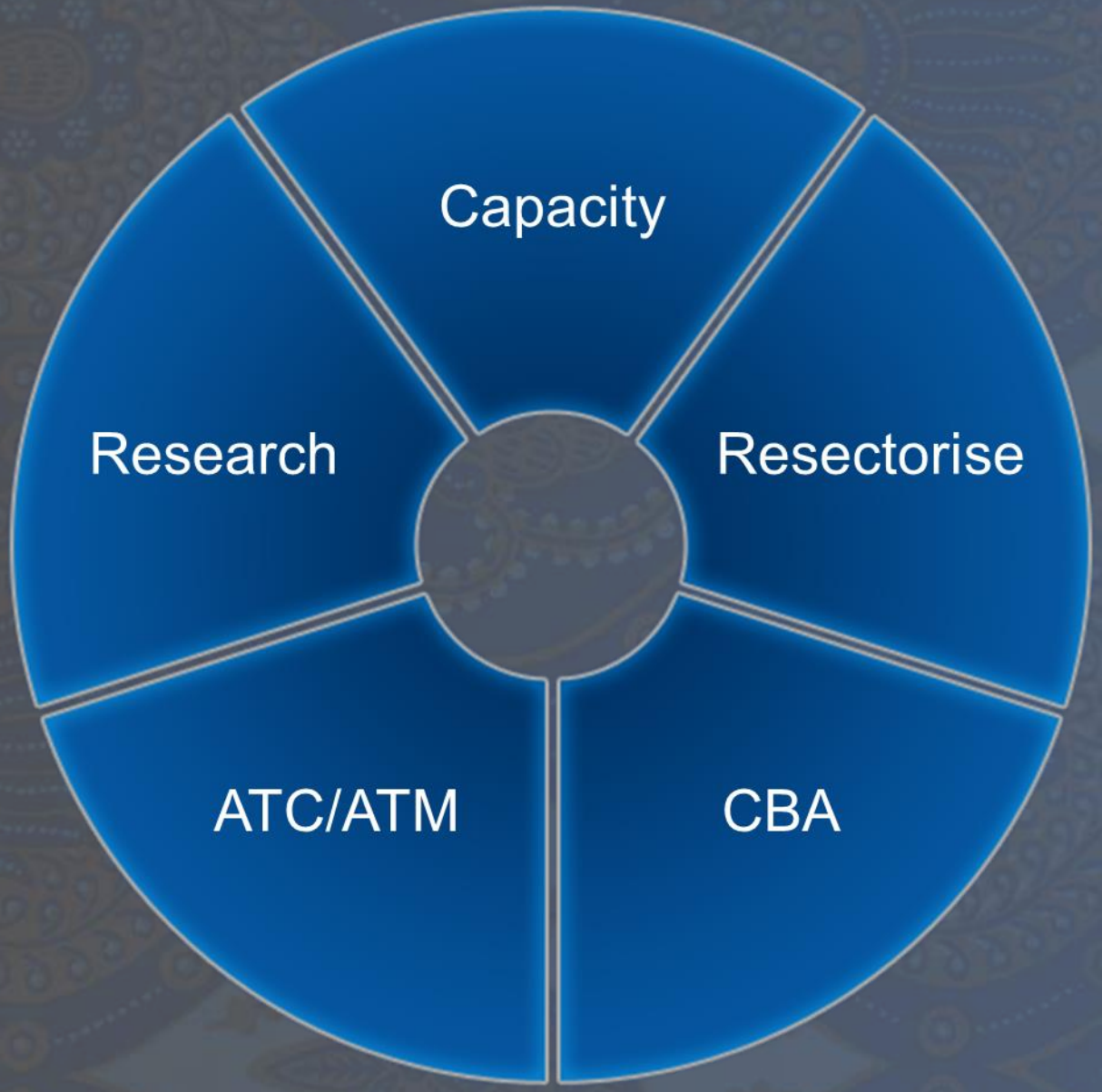
Chart Example - 24 Hours Sector Activity

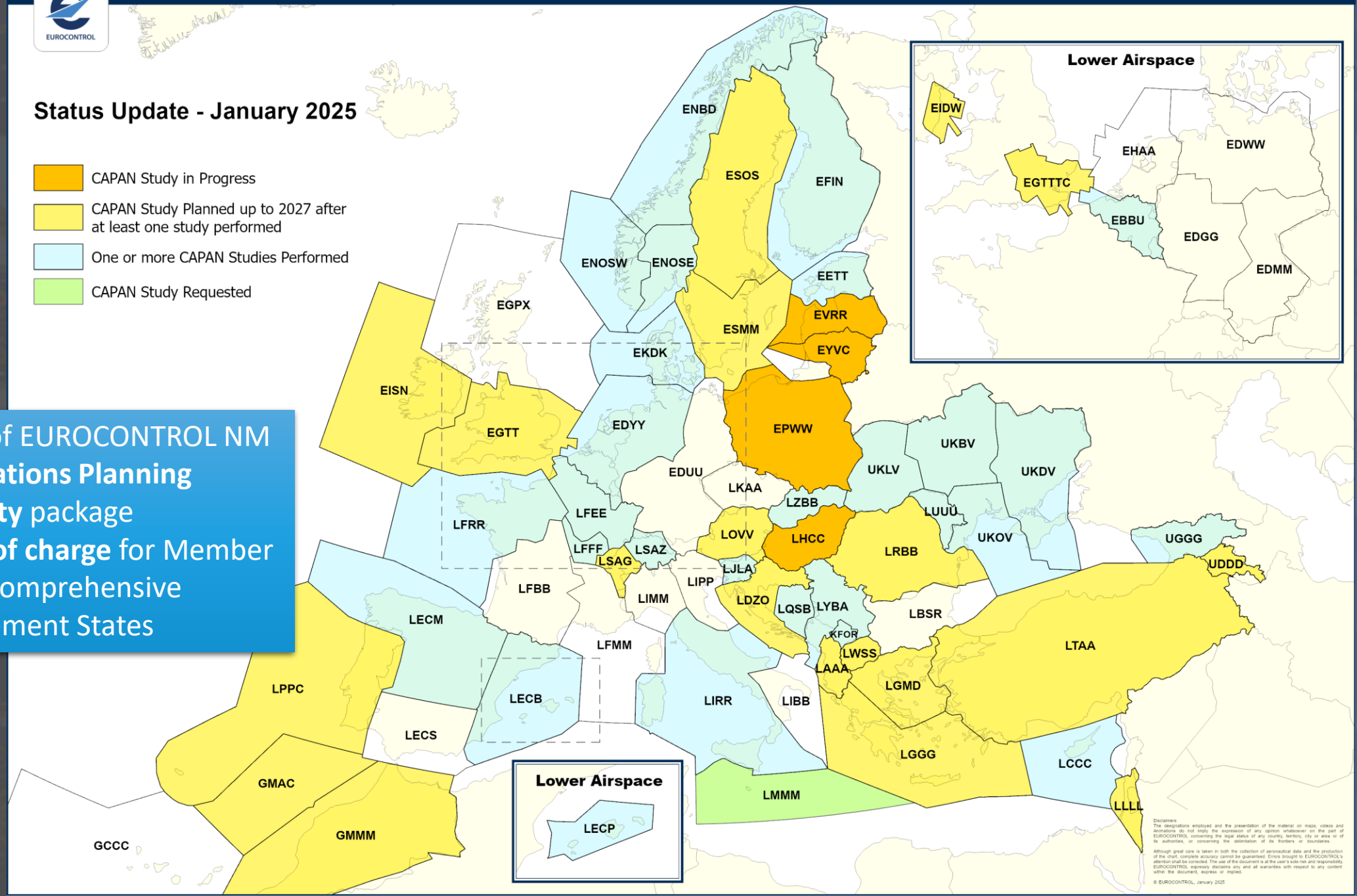
Relationship Between Sector Entries and Controller Workload



Where to use CAPAN



CAPAN STUDIES



- Part of EUROCONTROL NM **Operations Planning activity** package
- **Free of charge** for Member and Comprehensive Agreement States

Thank you

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