Capacity Planning and Assessment

Additional considerations

Air Traffic Services System Capacity Seminar/Workshop
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Summary
**Autumn**
- Traffic Forecast update
- Traffic Demand and Distribution
- Capacity Requirements and Delay
- Interactive Capacity Planning meetings with ANSPs
- ANSP Plans

**Spring**
- Traffic Forecast
- Network Delay Forecast Update NOP

**Winter**
- Annual Performance Analysis - Network Operations Report –(the NOR)
- Consolidation of Plans - Network Operations Plan (the NOP)

**Summer**
- Evaluation of Summer performance
- ACC Capacity Baselines

**Capacity Planning**

- Tool NEST (SAAM + NEVAC)
- Demand Data Repository DDR2

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Network Manager nominated by the European Commission

09/06/2016 3
Several approaches to workload modelling

- Workload self-assessment
- Task time models
- Traffic/sector complexity models

Different workload vs. capacity relationships

\[ \text{Workload thresholds} \]

Different assessment process

- Numerical Estimates
- Fast-time Simulations
- Real Time Simulations

Several valid methodologies available
CAPAN

Simulation Methodology

Sector Capacity

Controller Workload
Fast Time Simulation in ATM

- Events at Sector
- Actions
- Tasks
- Workload
CAPAN

RCAPAN  70%

Regression Analysis
Conflict Detection & Resolution
Input Data

Environment Data
- Route network
- Airspace structure
- Sectors...

Basic traffic Data
- Flight plans (24H Traffic)
- A/C Performances...

Simulation Parameters
- Conflict Detection/Resolution
- Procedures ...
- Separation minima's

ATC Tasks
Sector manning

RCAPAN Simulation Engine
Conflict Detection & Resolution

A conflict is detected if time and/or distance separation between two flights is infringed at any time while crossing the portion of airspace under control.

An action is taken to solve the conflict depending on:
- Type of conflicts
- Conflict evolution
- System capabilities

Define time and/or distance thresholds for separation infringement.

Define controller conflict resolution logic.
Conflict Geometry
Horizontal Plane
Conflict Attitude
Vertical Plane

1. Both aircraft at the same level in cruise

2. One aircraft in cruise, one aircraft in climb or descent

3. Both aircraft either in climb or descent
## Conflict Types

### A minimum of 9 types of conflicts

<table>
<thead>
<tr>
<th>RADAR Conflict Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Two aircraft on the same track at the same flight level in cruise.</td>
</tr>
<tr>
<td>Type 2</td>
<td>Two aircraft on the same track, one of which is in climb or descent.</td>
</tr>
<tr>
<td>Type 3</td>
<td>Two aircraft on the same track, both of which are in climb or descent.</td>
</tr>
<tr>
<td>Type 4</td>
<td>Two aircraft on crossing tracks, both in cruise at the same flight level.</td>
</tr>
<tr>
<td>Type 5</td>
<td>Two aircraft on crossing tracks, one of which is in climb or descent.</td>
</tr>
<tr>
<td>Type 6</td>
<td>Two aircraft on crossing tracks, both of which are in climb or descent.</td>
</tr>
<tr>
<td>Type 7</td>
<td>Two aircraft on opposite tracks, both of which are in cruise at the same flight level.</td>
</tr>
<tr>
<td>Type 8</td>
<td>Two aircraft on opposite tracks, one of which is in climb or descent.</td>
</tr>
<tr>
<td>Type 9</td>
<td>Two aircraft on opposite tracks both of which are in climb or descent.</td>
</tr>
</tbody>
</table>
Conflict Detection

Conflict Types

Separation Minima

ATC Tools

Actual Minimum Separation Thresholds

Separation Minimum distances need to be defined for all types of conflicts.

These figures are used to detect and discriminate conflicts for all simulated flight profiles.
Controller Separation Thresholds

Monitoring Threshold:
- Controller will monitor closely the situation
- Controller will not modify the flight trajectory

Intervention Threshold:
- Controller will modify the flight trajectory to ensure safe (and comfortable) distance between the involved flights
Conflict Detection Thresholds: An Example

- Applicable Separation Minima: 5nm
- Conflict **Type 1**: Parallel Same Direction, Same Level
- ATC Tools: CPA calculation between two flights based on present heading and speed
- Detection starting as soon as flights are within controller window

Faster aircraft behind

Slower aircraft in front

**Case 1**

a. Controller assesses CPA to be 6 nm
b. Even though CPA > Sep.Min. controller takes an action

**Case 2**

a. Controller assesses CPA to be 10 nm
b. Controller does not intervene
c. Controller might monitor the evolution of the conflict

A possible threshold for conflicts **Type 1** could be 10 nm
Conflict Resolution

A conflict can be solved in many different ways, for example:

- Level Change
- Speed control
- Vectoring
- Direct-To

Workload assessment needs to be able to take this into account either by simulating it realistically or by reproducing the proper load for the controller → resolution strategy

A set of rules has to be defined to choose the right resolution according to actual conflict evolution, local procedures and modus operandi
Conflicts and Tasks

Flight Profile Calculation → Conflict Detection → Conflict Resolution

Tasks for conflict detection

Conflict Resolution Rulebase

Update Flight Profile (depending on resolution strategy)

Tasks representing all performed actions

Actual Minimum Separation Thresholds

Tasks for conflict resolution
Input Data

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Simulation Parameters
- Conflict Detection/Resolution
- Procedures...
- Separation minima's

ATC Tasks
Sector manning

RCAPAN Simulation Engine
Tasks and Task Categories
Events and Tasks

EZY770N A319 LGAV LIMC
EFL380 XFL340

South Sector

West Sector

Descent Clearance

Flight Level Verification

First Call

Last Call

Flight Info

Conflict Search

First Call

Last Call

08h21 08h38 08h45 08h59 09h11 09h15 09h16
Task Definition

- Tasks reproduce controller actions
- Tasks are triggered by discrete ATC events e.g. entry into a sector, entry into controller window, start of descent, etc.
- Tasks can be associated to specific conditions e.g. airport, route, flight level, fight attitude
- Tasks can be grouped/chained to represent a set of connected actions

→ One Task = Many Actions vs. Many Tasks = One Action

Low Granularity → High Granularity
Task Categories

Tasks categories are chosen:
- To cover all discrete actions a controller can perform
- To reflect work organisation
- To address analysis interest

Categories and Sub-Categories can be defined as appropriate

Example:

**Main Category - Radar**

It covers all actions to detect and solve conflicts

Sub-category for each action
- e.g. Vector ~ Sub-cat.: TX Vector
  - Monitor vector ~ Sub-cat.: Radar
  - Monitoring
  - Passing traffic information ~ Sub-cat.: TX traffic info

Sub-Category for groups of actions
- e.g. Vectors
  - + Monitor
  - + Passing Traffic
  - ~Conflict
  - Radar
  - Info
  - Resolution
Controller Tasks & Categories
Eurocontrol CAPAN

- 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.
Sector Capacity Assessment
General conclusions
Sector Capacity Assessment

Sector Capacity is driven by controller workload

A capacity assessment methodology should define:

- task categories and tasks
- conflict detection and resolution mechanisms
- a set of rules to mimic controller reasoning
- a threshold for average theoretical working time corresponding to sector capacity
- a technique to establish the relation between workload and capacity indicator
Sector Capacity Assessment

Assessment as a standardized process

A capacity assessment methodology should:

- Use a simulation engine which allows reproducing the ATC environment
- Follow a reiterative process of validation for every assessment case
- **INVOLVE active ATC staff** throughout the full process
- Encourage transparency and teamwork at all stages
- Use expert staff to guarantee that input data and simulation are properly carried out

→ **WRONG INPUT ~ WRONG OUTPUT**
Sector Capacity Assessment

Usability of results

A capacity assessment methodology should:

- Establish a comprehensive and possibly standardized set of results
- Define capacity related KPIs
Useful Links

- EUROCONTROL: [www.eurocontrol.int](http://www.eurocontrol.int)
- Network Manager: [http://www.eurocontrol.int/network-manager](http://www.eurocontrol.int/network-manager)
- Operations Planning: [http://www.eurocontrol.int/operations-planning](http://www.eurocontrol.int/operations-planning)
- ATFCM: [http://www.eurocontrol.int/articles/air-traffic-flow-and-capacity-management](http://www.eurocontrol.int/articles/air-traffic-flow-and-capacity-management)