A BRIEF HISTORY OF RVSM

SAULO SILVA
ATM Section
Air Navigation Bureau, ICAO HQ
April 2010
Objective

To present a brief history related to the development and implementation of RVSM.
Outline

➢ The Beginning
➢ The Vertical Separation Panel
➢ Early Regional Air Navigation (RAN) Meetings
➢ RGCSP
➢ Time for development
➢ Results
1940s: 1,000 feet (300 meters) in all cases except 500 feet (150 meters) when:

- Aircraft are being flown in conditions of flight visibility of less than 3 miles (5km) but not less than 1 mile (1.5 km).
- Aircraft are holding above a well defined top of cloud or other formation during the hours of darkness if the pilot reports indicate the forward visibility is not less than 1 mile (1.5 km).
Aircraft are on flight paths which will cross at or near a reporting point, provided that the aircraft concerned are using the same altimeter setting.

No separation is required for enroute traffic above a well defined top of cloud or other formation if frequent in-flight weather reports indicate a generally unlimited ceiling on top and flight visibility of at least 3 miles (5km). During the hours of daylight, holding aircraft operation under these conditions will require no separation.
The advent of commercial turbo jet aircraft operating at high levels necessitated a reevaluation of the vertical separation minimum.

A Vertical Separation Panel was therefore formed in June 1954.

The Panel identified those factors which were likely to contribute towards the greatest loss of separation and proposed steps that should be taken to reduce or eliminate their influence.
The 1958 RAC/SAR Divisional Meeting

“The vertical separation minimum shall be 305 meters (1000 ft) except that, above a level to be determined on the basis of Regional Air Navigation Agreements, 610 meters (2000 ft) shall be established as the vertical separation minimum. This level should not be higher than an altitude of 8850 meters (29000 ft) or flight level 8850 metric (290)”. 
The 1958 RAC/SAR Divisional Meeting

- The vertical separation minimum between IFR traffic shall be a nominal 300 meters (1000 ft) below an altitude of 8850 meters (29000 ft) or flight level 290 and a nominal 600 meters (2000 ft) at or above this level, except where, on the basis of regional air navigation agreements, a lower level is prescribed for the change to a nominal 600 meters (2000 ft) vertical separation minimum.
That, in view of the importance of vertical separation criteria in the planning of Air Traffic Services for NAT Region, as well as for other regions of high traffic density, the work of the Organization in the field of vertical separation be pursued vigorously to an early conclusion and be presented in a form suitable for early application in regional ATS.
That in view of the importance of vertical separation in the planning of air traffic services particularly in regions of higher traffic density and the desirability of reducing vertical separation intervals above Flight Level 290, work in the field of vertical separation be vigorously pursued by all concerned to an early conclusion and presented to ICAO in a form suitable for early application in ATS planning on a world-wide basis, or, if this is not attainable, at least on a regional basis.
Recommendation - Technical Measures by States and Operators of aircraft intended to be used for operation in that part of the NAT Region where 1000 feet vertical separation is to be applied above FL290:
SPECIAL NAT RAN 1965 MEETING

- Ensure as soon as possible that operators are taking all necessary measures for installation, calibration and maintenance of altimeter systems and autopilots in accordance with the latest available methods; and

- Assure themselves as soon as possible by means of flight tests, as appropriate, that calibration, maintenance and operating techniques used by the operators are such as to achieve the necessary degree of reliability and accuracy of altimeters and autopilots.
The changeover level was established at FL 290 on a global basis.

At the same time, it was considered that the application of a reduced VSM above FL 290, on a regional basis and in carefully prescribed circumstances, was a distinct possibility in the not too distant future.

Accordingly, ICAO provisions stated that such a reduced VSM could be applied under specified conditions within designated portions of airspace on the basis of regional air navigation agreement.
World fuel shortages and the resultant rapid escalation of fuel costs

Growing demand for a more efficient utilization of the available airspace, emphasized the necessity for a detailed appraisal of the proposal to reduce the VSM above FL 290.
DEVELOPMENT OF THE RVSM - WHY SO MUCH INTEREST?

- Fuel-burn penalty of about 1 percent for each 1000 ft below optimum cruise altitude
- RVSM was single best thing to do - fuel-burn reduction far outweighed any horizontal plane separation reductions, for example, 30 NM lateral/30 NM longitudinal
- RVSM provides (theoretical) doubling of capacity in same airspace
- Achievable without major change to aircraft or ATC system
- 1971 – RGCSP/1
REVIEW OF THE GENERAL CONCEPT OF SEPARATION PANEL

- ICAO Review of the General Concept of Separation Panel (RGCSP) (1982): agreed to begin task to determine RVSM technical feasibility

- Several States represented in the Panel began individual programs, coordinating efforts within the Panel: Canada, Eurocontrol (France, Germany, Netherlands, United Kingdom), Japan, the former USSR and the United States
REVIEW OF THE GENERAL CONCEPT OF SEPARATION PANEL

- RGCSP/6 (1988): “Recommended that RVSM was technically feasible”

- RGCSP/7 (1990): draft RVSM guidance material was produced - Doc 9574

- ICAO ANC (1990): approved draft guidance material and draft Standards and Recommended Practices (SARPS) to Annex 2

- 1997 – 27 March, First RVSM Implementation
WHY SO LONG?

- Aircraft maintain assigned flight level by sensing and measuring pressure and converting pressure to feet via ICAO Standard Atmosphere.
- Errors in the sensing and conversion process not easily estimated.
  - Observed errors in pressure altitude on flight deck or in SSR Mode C reflect only differences between cleared (or commanded) pressure altitude and pressure altitude actually flown.
  - Difference between aircraft-measured pressure and constant pressure surface defining flight level is what is needed.
- Difference called altimetry system error (ASE).
WHY SO LONG?

- Flight levels (constant pressure) defined by constant pressure surfaces in atmosphere
- Constant pressure surface over a geographic region is not at constant geometric height
  - In general: constant pressure surfaces increase in geometric height from pole to equator
  - In general: in temperate climates, constant pressure surface geometric heights are higher in summer than winter
- To determine errors in altimetry system, need information about geometric height of flight levels and geometric height of aircraft - neither of which is available readily.
Development of the RVSM - The Major Problem

FL 350 = Constant Pressure Altitude

FL 350 Geometric Height
Height Keeping Performance Errors

FL 350 Geometric Height

Aircraft geometric height

Total Vertical Error (TVE) = Altimetry System Error + Assigned Altitude Deviation
= ASE + FTE(AAD)
WAS IT WORTH IT?

- Operators have found benefits greater and costs less than predicted.
- ATC units report little difficulty with RVSM procedures.
- ATC units able to offer more desirable routings.
- ATC units report RVSM provides more operational flexibility.
WAS IT WORTH IT?
Outline

- The Beginning
- The Vertical Separation Panel
- Early Regional Air Navigation (RAN) Meetings
- RGCSP
- Time for development
- Results
A BRIEF HISTORY OF RVSM

THANK YOU

QUESTIONS?

SAULO JOSÉ DA SILVA
SDASILVA@ICAO.INT
ICAO RVSM Implementation Safety Assessment Seminar
Nairobi, 19-22 April 2010

AFI RVSM Cost Benefit Analysis Forecast

Presented by Prosper ZO’O MINTO’O
Assistant Regional Director, IATA AFI
Safety, Operations and Infrastructure
to represent, lead and serve the airline industry
Plan

I. Introduction

II. AFI Traffic Forecast

III. AFI RVSM Cost Benefit Analysis (CBA)
I - Introduction
Chicago Convention (1944)

Preamble: "...Therefore the undersigned governments, having agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically..."

Annex 11: Air traffic control service. A service provided for the purpose of preventing collisions ...and expediting and maintaining an orderly flow of air traffic.
**Air Traffic Management [ATM]**

(Source: ICAO ATM Operational Concept)

- **Definition.** Air Traffic Management [ATM] is defined as "the dynamic, integrated management of air traffic and airspace - **safely, economically, and efficiently** - through the provision of facilities and seamless services in collaboration with all parties".
II – AFI Traffic Forecast
AFI Traffic Forecasts for 2004 – 2020
(Source: ICAO Doc 9879)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NAM-AFI</td>
<td>3990</td>
<td>4248</td>
<td>4524</td>
<td>4817</td>
<td>5130</td>
<td>5463</td>
<td>5818</td>
<td>10311</td>
<td>6.5</td>
<td>5.9</td>
<td>6.1</td>
</tr>
<tr>
<td>EUR-AFI</td>
<td>131319</td>
<td>137623</td>
<td>144229</td>
<td>151152</td>
<td>158407</td>
<td>166010</td>
<td>173979</td>
<td>265057</td>
<td>4.8</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>MEA-AFI</td>
<td>43719</td>
<td>46413</td>
<td>49274</td>
<td>52310</td>
<td>55534</td>
<td>58956</td>
<td>62589</td>
<td>119118</td>
<td>6.2</td>
<td>6.6</td>
<td>6.5</td>
</tr>
<tr>
<td>ASP-AFI</td>
<td>10953</td>
<td>11468</td>
<td>12007</td>
<td>12571</td>
<td>13162</td>
<td>13780</td>
<td>14428</td>
<td>21563</td>
<td>4.7</td>
<td>4.1</td>
<td>4.3</td>
</tr>
<tr>
<td>INTRA AFI</td>
<td>77988</td>
<td>84937</td>
<td>92506</td>
<td>100749</td>
<td>109727</td>
<td>119505</td>
<td>130154</td>
<td>296998</td>
<td>8.9</td>
<td>8.6</td>
<td>8.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>267969</td>
<td>284689</td>
<td>302538</td>
<td>321599</td>
<td>341959</td>
<td>363714</td>
<td>386967</td>
<td>713048</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
</tr>
</tbody>
</table>
**Reduced Vertical Minimum Separation (RVSM)**

Cruising levels as per direction of flight – FL280 to FL430

<table>
<thead>
<tr>
<th>Route from 180 degrees to 359 degrees*</th>
<th>Route from 000 degrees to 179 degrees *</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>← FL 430 (non RVSM level above RVSM airspace)</strong></td>
<td><strong>FL410 →</strong></td>
</tr>
<tr>
<td><strong>← FL400</strong></td>
<td><strong>FL390 →</strong></td>
</tr>
<tr>
<td><strong>← FL380</strong></td>
<td><strong>FL370 →</strong></td>
</tr>
<tr>
<td><strong>← FL360</strong></td>
<td><strong>FL350 →</strong></td>
</tr>
<tr>
<td><strong>← FL340</strong></td>
<td><strong>FL330 →</strong></td>
</tr>
<tr>
<td><strong>← FL320</strong></td>
<td><strong>FL310 →</strong></td>
</tr>
<tr>
<td><strong>← FL300</strong></td>
<td><strong>FL290 →</strong></td>
</tr>
<tr>
<td><strong>← FL280 (non RVSM level below RVSM airspace)</strong></td>
<td></td>
</tr>
</tbody>
</table>
# Flights and Hours of operation

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>International flights</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006 (2004 x 5% pa) (flights)</td>
<td>245,000</td>
<td>257,250</td>
<td>270,113</td>
<td>283,618</td>
<td>297,799</td>
</tr>
<tr>
<td><strong>Average International flight duration (hours)</strong></td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total hours</strong></td>
<td>1,470,000</td>
<td>1,543,500</td>
<td>1,620,675</td>
<td>1,701,709</td>
<td>1,786,794</td>
</tr>
<tr>
<td><strong>Domestic flights 2006 (South Africa) (flights)</strong></td>
<td>200,000</td>
<td>210,000</td>
<td>220,500</td>
<td>231,525</td>
<td>243,101</td>
</tr>
<tr>
<td><strong>Average domestic flight duration (hours)</strong></td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total hours</strong></td>
<td>260,000</td>
<td>273,000</td>
<td>286,650</td>
<td>300,983</td>
<td>316,032</td>
</tr>
<tr>
<td><strong>Total RVSM flights</strong></td>
<td>445,000</td>
<td>467,250</td>
<td>490,613</td>
<td>515,143</td>
<td>540,900</td>
</tr>
<tr>
<td><strong>Total RVSM hours</strong></td>
<td>1,730,000</td>
<td>1,816,500</td>
<td>1,907,325</td>
<td>2,002,691</td>
<td>2,102,826</td>
</tr>
<tr>
<td></td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
<td>Year 4</td>
<td>Year 5</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>Ave fuel consumption (kg/h)</strong></td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td><strong>Total fuel consumption on International flights</strong></td>
<td>5,880,000,000</td>
<td>6,174,000,000</td>
<td>6,482,700,000</td>
<td>6,806,835,000</td>
<td>7,147,176,750</td>
</tr>
<tr>
<td><strong>Percentage reduction in fuel consumption (%)</strong></td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total fuel saved</strong></td>
<td>88,200,000</td>
<td>92,610,000</td>
<td>97,240,500</td>
<td>102,102,525</td>
<td>107,207,651</td>
</tr>
<tr>
<td><strong>Ave fuel reduction (kg)</strong></td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td><strong>Total fuel consumption on domestic (SA) flights</strong></td>
<td>800,000,000</td>
<td>840,000,000</td>
<td>882,000,000</td>
<td>926,100,000</td>
<td>972,405,000</td>
</tr>
<tr>
<td><strong>Percentage reduction in fuel consumption (%)</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total fuel saved</strong></td>
<td>8,000,000</td>
<td>8,400,000</td>
<td>8,820,000</td>
<td>9,261,000</td>
<td>9,724,050</td>
</tr>
<tr>
<td><strong>Ave fuel reduction (kg)</strong></td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td><strong>Total fuel saved in RVSM environment</strong></td>
<td>96,200,000</td>
<td>101,010,000</td>
<td>106,060,500</td>
<td>111,363,525</td>
<td>116,931,701</td>
</tr>
<tr>
<td><strong>Fuel cost in USD per USG Aug 2005 (USD)</strong></td>
<td>3.23</td>
<td>3.71</td>
<td>4.27</td>
<td>4.91</td>
<td>5.65</td>
</tr>
<tr>
<td><strong>Total savings due to reduced fuel consumption</strong></td>
<td>102,617,569</td>
<td>123,910,715</td>
<td>149,622,188</td>
<td>180,668,792</td>
<td>218,157,567</td>
</tr>
</tbody>
</table>
# Delays

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average block hour cost</strong></td>
<td>6,000</td>
<td>7,200</td>
<td>8,640</td>
<td>10,368</td>
<td>12,442</td>
</tr>
<tr>
<td><strong>Average delay reduction due RVSM (SA flight levels - 150 flights)</strong></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total hours saved</strong></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total savings</strong></td>
<td>120,000</td>
<td>120,000</td>
<td>120,000</td>
<td>120,000</td>
<td>120,000</td>
</tr>
</tbody>
</table>
## Payload

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimate Revenue per flight due increased payload (USD)</strong></td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total revenue (USD)</strong></td>
<td>4,450,000</td>
<td>4,672,500</td>
<td>4,906,125</td>
<td>5,151,431</td>
<td>5,409,003</td>
</tr>
<tr>
<td></td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
<td>Year 4</td>
<td>Year 5</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>ARMA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>5,200,000</td>
<td>5,512,000</td>
<td>5,842,720</td>
<td>6,193,283</td>
<td>6,564,880</td>
</tr>
<tr>
<td>Height Monitoring</td>
<td>4,900,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Aircraft operators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altimetry MASPS</td>
<td>530,500</td>
<td>562,330</td>
<td>596,070</td>
<td>631,834</td>
<td>669,744</td>
</tr>
<tr>
<td>Inspections / upgrades</td>
<td>38,196,000</td>
<td>12,732,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>ANSPs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATM Upgrades</td>
<td>30,000,000</td>
<td>30,000,000</td>
<td>30,000,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total (USD)</strong></td>
<td>78,826,500</td>
<td>48,806,330</td>
<td>36,438,790</td>
<td>6,825,117</td>
<td>7,234,624</td>
</tr>
</tbody>
</table>
### Summary

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel savings</th>
<th>Delay savings</th>
<th>Payload increase</th>
<th>Total costs</th>
<th>Total annual savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>102,617,569</td>
<td>120,000</td>
<td>4,450,000</td>
<td>78,826,500</td>
<td>28,361,069</td>
</tr>
<tr>
<td>Year 2</td>
<td>123,910,715</td>
<td>120,000</td>
<td>4,672,500</td>
<td>48,806,330</td>
<td>79,896,885</td>
</tr>
<tr>
<td>Year 3</td>
<td>149,622,188</td>
<td>120,000</td>
<td>4,906,125</td>
<td>36,438,790</td>
<td>118,209,524</td>
</tr>
<tr>
<td>Year 4</td>
<td>180,668,792</td>
<td>120,000</td>
<td>5,151,431</td>
<td>6,825,117</td>
<td>179,115,107</td>
</tr>
<tr>
<td>Year 5</td>
<td>218,157,567</td>
<td>120,000</td>
<td>5,409,003</td>
<td>7,234,624</td>
<td>216,451,945</td>
</tr>
</tbody>
</table>
International Civil Aviation Organization

AFI RVSM Implementation Safety Seminar

AFI RVSM Backdrop

Six Eighty Hotel, Nairobi, Kenya
19-23 April 2010

Seboseso M Machobane
Regional Officer, Eastern and Southern African Office
Seboseso.Machobane@icao.unon.org
Sharing the Limited Jet Levels

FL410

FL390

FL400
Overview

- Early views
- APIRG & SP AFI RAN
- Safety Management
- Tactical Action Group (TAG)
- Conclusion
decision 12/66: implementation of rvsm

that the planning and evolutionary implementation of rvsm in the afi region be carried out and the problems associated with the implementation of rvsm in europe and other afi interface areas be considered within the framework of the implementation co-ordination groups (icgs) or apirog sub-groups as appropriate.
Decision 13/58: Establishment of a Task Force on RVSM and RNAV/RNP Implementation

Conclusion 13/85: Initial Implementation of RVSM in the AFI Region

- That RVSM be implemented in the AFI Region concurrently with or soon after its implementation in the EUR Region, and initially between fl 350 and fl 390

Conclusion 13/86: Seminars/Workshops on RVSM and RNAV/RNP
EARLY VIEWS

What do we remember?

What has changed, 11 Years on?

- Resistance to change
- Limited understanding about the concept
- Uncertain about safety implications
- More pressing priorities
- Unaware/lack of concern about the user benefits
- etc., ...
- Skeptical and pessimistic
- Everything is just fine; if ain’t broke don’t fix it
- Under prioritized RVSM safety resource (e.g. no NPM)
- etc., ...

Sebo
2 months after successful RVSM Implementation on September 25

Recommendation 6/6 — Operational safety assessment methodology

That APIRG adopt the ATM Performance Objective: Operational Safety Assessment Methodology as contained in the performance framework form in Appendix B to the Report on Agenda Item 6

Recommendation 6/7 – Establishment of a Tactical Action Group (TAG)
Rec. 6/8 – RVSM monitoring & follow-up activities

That AFI States support:

Long term –

- Submission of State RVSM operationally approved aircraft ARMA;
- support to the AFI height monitoring programme;
- collection of safety assessment data;
- personnel to fulfil the role of RVSM NPM;
- establishment of the scrutiny group in 2009;
- measures to reduce the large number of horizontal incidents in the AFI Region.
What flexibility is there?

- RVSM Airspace is a thin layer under increasing demand
- As aircraft navigation precision increases, missing each other gets harder, risk of collision increases
- As opposed to a low level CFIT, an RVSM Mishap involves at least two aircraft, lots of lives!
- We share our airspace with non AFI aircraft; consequences are not just AFI…
What flexibility is there?

Eurocontrol expecting 4,000 flights on Sunday compared to 24,000

Kenya losing Sh300m daily over cancelled flights

(Sunday Nation)

Financial pressure pushes some airlines to test the skies
What is safety?

- Zero accidents or serious incidents
  - a view widely held by the travelling public
  - some managers still refer to lack of incidents as being safe
- Freedom from hazards (i.e. those factors which cause or are likely to cause harm)
- Attitudes towards unsafe acts and conditions by employees of aviation organizations
- Error avoidance
- Regulatory compliance (if rules are not broken, we are safe)
- …?
Safety Management
Safety Management

The need to be predictive is imperative

- Considering the forces and magnitudes of energy involved in flying, it’s known level of safety is NOT by chance.
- A lot conscious effort is needed, continuously.
- We nap on the wheel, we take a hit.
- A good part of our senior management is not from technical or safety backgrounds (moreover, they migrate more); we need to educate them, continually.
- Safety management is conscious pre-planned process that is executed according to plan.
TACTICAL ACTION GROUP
(Lessons and observations)

There are much more unsatisfactory condition reports than we readily estimate.

There is reluctance to report particularly from:
- CAAs
- ANSPs

There is reluctance to investigate airspace incidents.

There is reluctance to accommodate TAG missions in States.

There’s work to be done!
RVSM Post Launch Imperatives

- SP AFI RAN Rec. 6/7
- Implement SSP & SMS
  - *(This is not the SMS of 2005)*
- SSP framework guidance in Appendix to Annexes
- SMS Standard framework in Appendix to Annexes
- More guidance in Doc 9859
- Safety Management Training is imperative
  - *(ACIP Website: http://www2.icao.int/en/acip/)*
- etc.;...
CONCLUSION

- We have come a long way in views and understanding. Great, but we cannot relax.
- So long as we fly, some obligations will just never go away.
- At the least/minimum, we should implement ICAO provisions.
- We have an obligation keep our senior managers on board.
Thank you
questions...
ICAO ESAF OFFICE
RVSM IMPLEMENTATION
SAFETY SEMINAR
(Nairobi, 19 - 22 April 2010)

Air Traffic Controllers Perspective
(Presented by IFATCA)
SUMMARY

• One and a half years after the implementation of the AFI RVSM between FL 290 to FL410 the Controllers in the region have had various experiences; this paper thus highlights these experiences.
Introduction

- On 25th September 2008 the AFI region implemented RVSM in the airspace between FL290 and FL410.
- This airspace became restricted to RVSM approved aircraft only except for those aircraft which would climb or descend unrestricted to/from levels above FL410.
This implementation was as a result of close monitoring and consultations by a team of experts that included ARMA, ICAO, IATA, ATNS, Kenya CAA, ASECNA, IFALPA and IFATCA. This AFI RVSM working group with the blessings from APIRG (Conc. 16/38) had approved the date of 25\textsuperscript{th} September 2008 for the implementation of the RVSM in the AFI region with approval from APIRG 16\textsuperscript{th} meeting held in Rwanda on 19-23 November 2007.
At the AFI RVSM TF 14th meeting the States had indicated that:

- the National Safety Plans (NSP),
- the CNS infrastructure to support the implementation of RVSM,
- The Letters of Agreement/ Letters of Procedures (LOA/LOP) between States and adjacent FIRs,
- had all been completed and the Pre-Implementation Safety Case (PISC) for the region had been completed and would be sent to the ICAO ANC for approval by June of 2008.
As the days drew closer to the implementation date, the AFI RVSM TF co-opted IFATCA into the Project Management Team (PMT). It was the mandate of this team to ensure that all the Tasks agreed on for the safe implementation was completed by the target date, and any difficulties resolved or contingencies put in place to deal with them.
Discussion

- At the time of implementation IFATCA had expressed concern that although the States had reported that all the necessary safety targets were met some ATC centers were not ready for the implementation, some controllers were not very conversant with the requirements and new ATM systems were yet to be validated. Some States had raised concern that their Communication infrastructure would not be ready by 25th September 2008 among them Angola and DRC.
These concerns the PMT believed would be overcome in the following few weeks before implementation and therefore the target date of 25\textsuperscript{th} September 2008 was accepted at the RVSM TF 14\textsuperscript{th} meeting in Nairobi on 26\textsuperscript{th}-28\textsuperscript{th} May 2008.

Due to the concerns expressed on individual unit readiness, IFATCA embarked on intense monitoring of the States preparation through the Member Associations.
Following the implementation, IFATCA member associations have provide the necessary feedback. In general the air traffic controllers in the region have been happy with the extra six flight levels created by the implementation of RVSM in the region. These extra levels have eased the congestion that were initially experienced on optimum levels like FL310-FL370 and created less workload for the controllers in the area of coordination.
• A number of ATC units reports difficulties with handling **State aircraft**. While a number of state aircraft are RVSM approved some are not. The AFI region handles a large volume of state aircraft and the requirement to provide 2000 feet separation between them and other traffic over stretch the airspace.

• In a region where large areas are not covered by surveillance equipment it is essential that information is received concerning the status of all flight; this is not happening as required.
Cases are sometimes not reported of Non RVSM approved flights entering RVSM airspace without authority; this happened a lot in the early part of implementation. Flight plans sometimes indicated that aircraft were RVSM approved and yet later it would be realized that this was not the case; the assumption that certain types of aircraft have the required capability have led to most of these breaches.
Although **Communication** was improved in the region before implementation, today communication failures have been in the increase in the region. Whereas this is a widespread problem in the region, Controllers mainly in the west and central African region are more affected; they continue to work with very limited communication facilities. Coordination between units is sometime very difficult, resulting into a number of ATC incidents in the region.
Due to the nature of provision of Air traffic services, certain types of incidents go un-reported because they are considered as normal operations; a good example is large altitude deviations due to turbulence. For this reason it is important to note that Safety case analysis may not reflect the true picture. It is important that all incidents irrespective of how small it is be reported.
Also reported is that in TCAS RA cases and Turbulence conditions, flight levels are changed with more than 500 feet; often a full flight level is changed e.g. from FL330 to FL350 or from FL330 to FL340 etc this sometimes without controllers being aware of the magnitude of change in flight level.
Conclusion

• The deficiencies that are still being realized in the AFI region are of great concern to the controllers. There is urgent need to address Communication deficiencies, especially between ground units for both RVSM and general safety of operations.
• The number of non-RVSM aircraft that operate in RVSM airspace (whether State aircraft or incorrect action or emergency traffic of non-RVSM non-State aircraft) must be monitored keenly and on-going assessment made on whether the safety of exclusive RVSM airspace continues to be valid.
• Pilot and controller education must continue on procedures in RVSM for dealing with turbulence (including the suspension of 1000 foot separation), and how to respond to TCAS RAs.

• The reporting of events (what to report, and reporting procedures, etc), especially reporting of Large Height Deviations must be encouraged.

• IFATCA would like to stress that the TAG should continue to address on-going issues.
Recommendation

- IFATCA recommends that this presentation be accepted as information paper.
ARMA APPROVAL PROCESS OVERVIEW

- How come the poster doesn’t have training
- This is just an overview all info is in TGL6.
- Madagascar is happy with process.
- Sudan is not happy with approval process.
  Kevin explained the process to Sudan
  Kevin explained ARMA Form 2 and Form 3
  Kevin explained AFI RVSM monthly returns F1, F2, F3, F4

POSC

- Conclusion 3 editorial problem to look at.
- Grey area to be addressed - remedial action route network to be re-looked.
- Concept of RVSM was not properly grasped.

RECOMMENDATION

- State approvals how do we assist States – ICAO is an umbrella and States approve acft.
- Train avionics in approving RVSM aircraft. ICAO must Audit States with their RVSM approvals. Re-training re-familiarization some delegates might have moved on ARMA to put a package together to dispatch to all AFI CAA. States need to assist each other.
- Comply AFI minimum requirements – most States comply and others don’t What is ICAO input to CAAs in AFI. CAA’s are responsible for HM ARMA and HM program to engage with CAAs and Operators.
- Ops error reporting improved – why don’t we get incidents from GND how do managers and Ops operate if they don’t know what errors are there.
- Victimization, fear and voluntary incidents reporting – non-punitive policy, education to pilots and controllers in reporting open safety culture.

OPS Error Reporting and Assessment should be consistent:

- IATA and ARMA to work together.

Reporting processes must be improved:

- IATA and ARMA teamed up for incidents freedom of reporting from ACC to ARMA.

TFC Flow data submission:

- First submission was by hand then States dep was created then ARMA is able to get data. Extra data analysis function billing VSAT IATA data or billing avenue.
Proportion acft GNSS
- ARMA to look at GNSS and aircraft manufacturers.

Updated all documents:
- Doc. 7030 to be updated. ATC Manual to be updated State letters to CAAs to be fully aware.

RVSM docs relating to PISC:
- Will be revisited.

SLOP implemented ICAO provisions:
- Realized and satisfied at SG/11.

SLOP Harmonized:
- ESAF and WACAF to decide.

Surveillance Review:
- State should ensure surveillance offering.

CPDLC re-inforced:
- State should provide as required – SG/11.

Unidirectional and/or parallel Routes:
- TF implemented to review AFI route network – States must be encouraged NAVAIDS.
- GNSS airspace in RVSM airspace.
- TF to be implemented when all requirements are met.

Management of non-RVSM civil acft in RVSM airspace to be reviewed. Descend acft out of RVSM band. How did it get there. CAA to support ATC who report these Ops, address courses.

Op, acft, RVSM approvals be in-force

AIS dep must sift this fplns. Databases should be available to States to cross-check RVSM approvals.
Pilots must be also educated – How do I know if pilot is lying – IFALPA to assist ARMA reports non-IFALPA pilots to CAAs pilots from abroad think this is bush airspace and even AFI pilots CAAs to educate operators.

Wrong LVL

- FLAS must be emphasized.
- Deviation acft need urgent attention. Flight deck discipline TCAS parameters.
- Any other comments.
- Hefty penalties, RVSM vigilance for our TLS.
- Transponder requirement on MEL procedures.
- Query transition airspace.
- Weather deviation frequency 121.5 mhz/123.45 mhz used is emergency not just weather. Contingency plan by IFALPA in AFI.
- SLOP radar or surveillance LD Pilots and ATC procedures Pilot does not have to inform ATC to be revisited.
- State acft.
- Post flight slide 300ft and more.
- Degradation of acft equip slide
- Pilots to notify ATC.
- Discrepancy weather encounter IATA and ICAO frequencies
- Severe turbulence only as a title.
- Mountain wave activity slide 2nd bullet if pilot ATC procedures ICAO, ASECNA website.
OUTCOME OF THE AFI RVSM IMPLEMENTATION SAFETY SEMINAR (RISS)
19-23 APRIL 2010

➢ National Programme Manager (NPM) as the National RVSM implementation focal
points should sensitize their civil aviation authorities (CAA) with regard to adherence
to the RVSM Approval processes.

➢ AFI CAA’s are to ensure that the State Approval processes are clearly understood by
the staff responsible for applying such processes and are adhered to by operators in
order to reduce incidents of violations.

➢ AFI CAA’s to ensure enough qualified CAA inspectors and adequate oversight of
RVSM approvals and to ensure effective enforcement where necessary.

➢ AFI CAA’s to ensure that the ARMA is supported in the AFI Height Monitoring
Program.

➢ NPMs continue following up RVSM implementation issues as stipulated in the
RVSM Implementation plan to ensure compliance

➢ To ensure optimal use of RVSM flight levels and efficiency in the upper airspace in
general, LOP’s should be re-addressed between Seychelles/Mumbai &
Mogadishu/Mumbai in order to address current costly level restrictions being
experienced.

➢ AFI ANSP’s to ensure that ATS service providers are properly trained in RVSM and
that proficiency checks are conducted periodically to ensure appropriate use levels in
RVSM airspace.

➢ Following discussion and review of contingency procedures relating to RVSM
operations within the AFI Region, the seminar wishes to request ICAO to review the
contents of both Chapter 15 (Procedures related to emergencies, communication
failure and contingencies) and Chapter 16 (Miscellaneous procedures), PANS ATM
(DOC 4444) with a view of converting contingency procedures which relate
specifically to Oceanic operation to general contingency procedures, for use both
Continently as well in Oceanic airspace as appropriate.

➢ CAA’s to communicate to all stakeholders information about the existence and
function of TAG.

➢ States to amend the LOA/LOP’s to include the requirement to exchange information
on individual aircraft/flight RVSM Status.

➢ CAA’s to ensure specifically appointed personnel for the collection of data. This
function could be assigned to existing staff but should be clearly, expressly assigned
and supported.
➢ CAA’s to ensure that NPM are supported to communicate with the ARMA and to provide necessary data.

➢ CAA’s to apply immediate enforcement actions on Non-RVSM operators who operate in RVSM airspace where shear negligence and/or willful misconducts are confirmed. The same applies to RVSM Approved operators who commit such violence.

➢ AFI State that have not already done so to ensure that RVSM approvals certificates are included in the list of docs to be carried onboard.

➢ AFI CAA’s should ensure that reporting procedures are in place in order to facilitate timely processing of RVSM related incidents or violations.

LIST OF PARTICIPANTS

<table>
<thead>
<tr>
<th>STATES</th>
<th>NAME</th>
<th>DESIGNATION/E-MAIL/TELEPHONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>Arquimedes F. Antunes Ferreira</td>
<td>Air Navigation Director Tel:+ 244912506739 Fax+ 244 222 390529 Email: <a href="mailto:arquimedesf@gmail.com">arquimedesf@gmail.com</a>, <a href="mailto:arquimedes.f@inavic.co.za">arquimedes.f@inavic.co.za</a></td>
</tr>
<tr>
<td>Chad</td>
<td>Tiraoguingue Sarahaoubaye</td>
<td>Head of CNS/ATM Division Tel: +23522525414 Fax:+ 235 22522909 Email: <a href="mailto:sarabaye_kk@yahoo.fr">sarabaye_kk@yahoo.fr</a></td>
</tr>
<tr>
<td></td>
<td>Madjingar Daidemkery</td>
<td>Civil Aviation Engineer Tel:+23566281087 Fax:+235 2252 2909 Email: <a href="mailto:madjingaranselme@yahoo.fr">madjingaranselme@yahoo.fr</a></td>
</tr>
<tr>
<td>Egypt</td>
<td>Mahmoud Mohamed Aly</td>
<td>Supervisor – ACC - Egypt NANC Tel: 002 010 685 1155 Email:<a href="mailto:redcoode@yahoo.com">redcoode@yahoo.com</a></td>
</tr>
<tr>
<td></td>
<td>Salaheldin Abouelhamd Atito</td>
<td>Administrative Director, ACC Egypt NANC Tel: 002 016 558-7600 Email: <a href="mailto:salahatito@hotmail.com">salahatito@hotmail.com</a></td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Lulseged Gulilat Desta</td>
<td>Deputy Director General Air Navigation ECAA Tel: 251 116650265 Fax: 251 6650281/269 Email: <a href="mailto:caa.airnav@ethionet.et">caa.airnav@ethionet.et</a></td>
</tr>
<tr>
<td></td>
<td>Taye Gemechu Megersa</td>
<td>Chief Air Traffic Controller Tel:+251116650517/519 Fax: +251116650515/281 Email: <a href="mailto:tayecatco@yahoo.com">tayecatco@yahoo.com</a></td>
</tr>
</tbody>
</table>

C:\Users\Indegwa\Desktop\2010 ATM MEETINGS\RVSM Safety SEMINAR\Fnl Delegates RVSM RISS.doc
<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Name</th>
<th>Title and Organization</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>Guinea</td>
<td>Fara Tolno</td>
<td>Chef de la Section Bases Aériennes et Navigation à la DNAC</td>
<td>Tel: +224 60544330 Fax: +224 304 53457 E-mail: <a href="mailto:tolnofara1@yahoo.fr">tolnofara1@yahoo.fr</a></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td>Maurice Bangoura</td>
<td>Chef du Département Organization, Méthodes et Informations Aéronautiques à l’Agence de la Navigation Aérienne (ANA)</td>
<td>Tel: +224 60531523 Fax: +224 30461862 Email: <a href="mailto:maikaviathioncivile@yahoo.fr">maikaviathioncivile@yahoo.fr</a></td>
</tr>
<tr>
<td>10.</td>
<td>Kenya</td>
<td>E. M. Njogu</td>
<td>Manager ATS - Kenya Civil Aviation Authority, Air Traffic Services</td>
<td>Tel: +254 20 827470-5 Fax: +254 20 822300 Email: <a href="mailto:enjogu@kcaa.or.ke">enjogu@kcaa.or.ke</a></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>Nicholas Muhoya Ngatia</td>
<td>Chief Airworthiness Inspector Kenya Civil Aviation Authority</td>
<td>Tel: +254 711 858647 Email: <a href="mailto:nmuhoya@kcaa.or.ke">nmuhoya@kcaa.or.ke</a></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>Patrick M. Kinuthia</td>
<td>Manager ANS JKIA / RVSM Manager</td>
<td>Tel:+254 733927 647 Fax: + 254 20 827 817 Email: <a href="mailto:pkinuthia@kcaa.or.ke">pkinuthia@kcaa.or.ke</a></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>Wycliff Ben Shiashia</td>
<td>ATM/OPS-KCAA</td>
<td>Tel: +254 20 827 470-5 Fax: + 254 413 432 069 Fax: + 254 413 433024 Email: <a href="mailto:bshiashia@kcaa.or.ke">bshiashia@kcaa.or.ke</a></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>F. K. Wakolo</td>
<td>CATCO HQs Kenya Civil Aviation Authority</td>
<td>Tel: + 254 722 343759 Fax: +254 20 822300 Email: <a href="mailto:fwakolo@kcaa.or.ke">fwakolo@kcaa.or.ke</a></td>
</tr>
<tr>
<td>15.</td>
<td>Madagascar</td>
<td>Ratsirarson Jean Muël Joé</td>
<td>Airworthiness Department Manager - Inspector B. P. “D” IVATO Aéroport</td>
<td>Tel:+261-2022-447-57 Fax:+261-2022-48400 Mobile:+261-3207-22184 Email: <a href="mailto:joe_ratsira@acm.mg">joe_ratsira@acm.mg</a></td>
</tr>
<tr>
<td>No.</td>
<td>Country</td>
<td>Name</td>
<td>Position/Role</td>
<td>Contact Details</td>
</tr>
<tr>
<td>-----</td>
<td>------------------</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>16</td>
<td>Malawi</td>
<td>Ian Chirwa</td>
<td>Malawi Airwing Air Staff Officer</td>
<td>Tel:+265 888 684 935 Fax: + 265 151 8401 Email:<a href="mailto:ianchirwa@yahoo.com">ianchirwa@yahoo.com</a></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Robray Ismael</td>
<td>Malawi Defence Forces Air Force Air Wing Engineer Staff Officer</td>
<td>Tel:+265 999 912174 Fax: + 265 1759645 Email:<a href="mailto:rismael.ismael@gmail.com">rismael.ismael@gmail.com</a></td>
</tr>
<tr>
<td>18</td>
<td>Rwanda</td>
<td>Makuza Alphonse</td>
<td>Chief, Air Traffic Controller</td>
<td>Tel:+ 250 788 470 186/0788354437 Fax: + 250 252 582609 Email:<a href="mailto:amakuza@caa.gov.rw">amakuza@caa.gov.rw</a>/info@caa.gov.rw</td>
</tr>
<tr>
<td>19</td>
<td>Seychelles</td>
<td>Esmee Martine Samson</td>
<td>Manager of Air Traffic Services –National RVSM Safety Manager</td>
<td>Tel: + 248 384039 Fax: + 248 384032 Email:<a href="mailto:esamson@scaa.sc">esamson@scaa.sc</a></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>Lineda M.M. Samson</td>
<td>SATCO-OPS – National RVSM Program Manager</td>
<td>Tel:+248 527207 Fax: +248 384032 Email:<a href="mailto:lsamson@scaa.sc">lsamson@scaa.sc</a></td>
</tr>
<tr>
<td>21</td>
<td>Somalia</td>
<td>A.B. Wanyama</td>
<td>Air Traffic Services Expert (Operations)/Deputy Project Coordinator</td>
<td>Tel:+ 254 207622785/6 Mobile:+ 254(0) 722725161 Fax: + 254 20 7122340 Email:<a href="mailto:athanas.wanyama@icao.unon.org">athanas.wanyama@icao.unon.org</a></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>Humphrey Kilei Mwachoki</td>
<td>FIC Supervisor</td>
<td>Tel:+ 254 207622785/6 Fax: + 254 20 7122340 Email:<a href="mailto:humphrey.mwachoki@icao.unon.org">humphrey.mwachoki@icao.unon.org</a></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>Ali Jama Abdi</td>
<td>Senior ATC</td>
<td>Tel:+ 254 207622785/6 Fax: + 254 20 7122340 Mobile: + 254 (2) 722706 956 Email:<a href="mailto:ali-jama-abdi@icao.unon.org">ali-jama-abdi@icao.unon.org</a></td>
</tr>
<tr>
<td>24</td>
<td>South Africa</td>
<td>Harry Roberts</td>
<td>ATM Specialist - South Africa ATNS</td>
<td>Tel:+ 2711 9610123 Fax: + 2711 961 0403 Mobile:+27 795058417 Email:<a href="mailto:harryr@atns.co.za">harryr@atns.co.za</a></td>
</tr>
<tr>
<td>No.</td>
<td>Location</td>
<td>Name</td>
<td>Position</td>
<td>Contact Information</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>----------------------------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>25</td>
<td>Sudan</td>
<td>Yahia Hassan Elhoda</td>
<td>RVSM National Programme Manager</td>
<td>Tel: + 249 9 12912 467 Fax: + 249 183 779 620 Email: <a href="mailto:ye1heday7@gmail.com">ye1heday7@gmail.com</a></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>Abdulmonem Elsheikh Ahmed</td>
<td>ATS Director</td>
<td>Tel: +249 775 925 Fax: + 249 784964 Email: <a href="mailto:abdulmonem_caa@yahoo.co.uk">abdulmonem_caa@yahoo.co.uk</a></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>Fathi Taha Ibrahim Mohamed</td>
<td>Senior Airworthiness Inspector</td>
<td>Tel: + 249 912307411 Fax: + 249 183 779 620 Email: <a href="mailto:soukrabfti@hotmail.com">soukrabfti@hotmail.com</a></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>Imad Elhag</td>
<td>Senior Air Traffic Controller</td>
<td>Tel: + 249991 219 7272 or + 249 126 462210 Email: <a href="mailto:emaddddddd@hotmail.com">emaddddddd@hotmail.com</a></td>
</tr>
<tr>
<td>29</td>
<td>Tanzania</td>
<td>Iqbal Sajan</td>
<td>Chief Air Navigation and Aerodrome Inspector</td>
<td>Tel:+ 255 754 351 626 Fax:+ 255 22 2118905 Email: <a href="mailto:isajan@tcaa.go.tz">isajan@tcaa.go.tz</a></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>Joseph Mbuluko</td>
<td>RVSM Programme Manager</td>
<td>Tel: + 255 (0) 754 314166 Fax: + 255 222 110 264 Email: <a href="mailto:mbuluko@yahoo.com">mbuluko@yahoo.com</a></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>Simon Hans Kawo</td>
<td>Principal Flight OPS Inspector</td>
<td>Tel:+255 754 783 744 Fax: +255 22 2111 951, 2115079/80 Email: <a href="mailto:skawo@tcaa.go.tz">skawo@tcaa.go.tz</a></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>Reward E. Amani</td>
<td>Head ATS</td>
<td>Tel:+255 787 000023 Fax: + 255 272 554 312 Email: <a href="mailto:amani@kadco.co.tz">amani@kadco.co.tz</a></td>
</tr>
<tr>
<td>33</td>
<td></td>
<td>Sigfrid Mallya</td>
<td>Airworthiness Inspector</td>
<td>Tel Mobile: + 255 757 476 035 Fax: + 255 222 11 8905 Email: <a href="mailto:smallya@tcaa.go.tz">smallya@tcaa.go.tz</a></td>
</tr>
<tr>
<td>34</td>
<td>Uganda</td>
<td>Ochan Alex Albinus</td>
<td>Manager ATM/NPM</td>
<td>Tel:+ 256 414 320368 Mobile: + 256 752 760 935 Fax: + 256 414 320964 Email: <a href="mailto:aochan@caa.co.ug">aochan@caa.co.ug</a>/ochanalex@yahoo.co.uk</td>
</tr>
</tbody>
</table>
| 35. | C: | Moses Sezibwa | Principal Air Traffic Management  
Tel: + 256 721 320 907  
Fax: + 256 414 320 964  
Email: msezibwa@caa.co.ug |
| 36. | ZIMBABWE | Richard Munyenyiwa | Chief Air Traffic Control Officer – Operations RVSM  
National Programme Manager  
Tel:+ 263 457 5183/7  
Fax: + 263 458 5100  
Email: rmunyenyiwa@caaz.co.zw |

**ORGANIZATIONS**

| 37. | ARMA | Kevin Ewels | Manager: ARMA - South Africa ARMA  
Tel: + 2711 928 6546  
Fax: + 2711 928 6546  
Email: afirma@atns.co.za |
| 38. | | Nqaba Ndebele | Database Specialist - ARMA Database Specialist  
Tel: + 2711 928 6544  
Fax: + 27 11 928 6546  
Email: arma@atns.co.za |
| 39. | ASECNA | Diallo Amadou Yoro | Chef Bureau Etudes ATS et Programme  
Tel: + 221-33869-5661/221-77671 328/ +221-77509-4459  
Fax: + 221 33 820 7495  
Email: diallomad@asecna.org |
| 40. | | Mohamed Mahmoud O. Taleb Ahmed | Chef Centre d’Evaluation de la Securite de Navigation Aerienne  
Tel:+ 221 33869 5746  
Fax: + 221 33820 2722  
Email: talebahmedmoh@asecna.org |
| 41. | IATA | ZO’O-Minto’o Prosper | Assistant Regional Director  
Safety, Operations and Infrastructure  
Tel: +278 274 67 413/27115232724  
Fax: +2711 5232701  
Email: ZooMintooP@iata.org |
| 42. | NOSS Collaborative | Chris Henry | Director  
Tel: + 1-512-797-0685  
Email: henry@nosscollaborative.org |
| 43. | Roberts FIR | Alimamy Dixon Conteh | Senior Air Traffic Control Officer (SATCO)  
Tel: + 231 688 7160  
Email: calimamydixon@yahoo.com or adconteh@hotmail.com |
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
| 44. | **ICAO - Dakar** | Sadou Marafa | Regional Officer ATM/SAR  
Tel: (221) 33 839 93 90  
Cel: (221) 76 683 78 43  
Fax: (221) 33 823 69 26  
E-mail: smarafa@dakar.icao.int  
Skype: icao-smarafa |
| 45. | **ICAO Nairobi** | Seboseso Mochobane | Regional Officer, ATM/SAR, ICAO, Nairobi  
Tel: + 254 20 7622372  
Fax: + 245 20 762 1092  
Mobile: + 254 (0) 717555811  
Email: seboseso.machobane@icao.unon.org |

----------

C:\Users\Indegwa\Desktop\2010 ATM MEETINGS\RVSM Safety SEMINAR\Fnl Delegates RVSM RISS.doc
Global ATM Operational Concept

SAULO SILVA
ATM Section
Air Navigation Bureau, ICAO HQ
April 2010
Objective

To present the concept and the steps towards the implementation of the future ATM system.
Presentation Outline

- History and Background
- ATM Community
- Concept components
- Guiding principles
- Expectations / KPA’s
- Key Conceptual Changes
- Information Management
- Expected benefits
- Summary
History and Background

- FANS
- Tenth Air Navigation Conference
- CNS/ATM Systems
- Global Coordinated Plan for Transition to ICAO CNS/ATM Systems
- Planning and Implementation Regional Groups embarked on an extensive effort
- SARPs, PANS, Guidance material
- Eleventh Air Navigation Conference
- ICAO’s commitment to adopt a business process approach.
Vision statement

To achieve an interoperable global air traffic management system for all users during all phases of flight, that
- meets agreed levels of safety
- provides for optimum economic operations
- is environmentally sustainable and
- meets national security requirements.
Global ATM Operational Concept

The global ATM operational concept is a vision that:

✓ describes how an integrated global ATM system should operate
✓ describes what is envisaged on the basis of services
✓ describes how the services form an integrated system
✓ utilizes an information rich environment, that solves most problems strategically, through a collaborative process
✓ provides States and industry with clearer objectives for the design and implementation of ATM and supporting CNS systems
Technology is not an end in itself
Requires a comprehensive concept for an integrated, global air navigation system, based on clearly-established operational requirements
Concept endorsed by the 11th Air Navigation Conference
Strategic Guidance Established
- ATM system requirements
- Transition strategy
- Performance framework
Next steps
- Global Performance Objectives to achieve measurable progress towards achievement of the vision of the concept
Performance Objectives

Global Performance Objective:

Improvements to the Air Navigation System that are on the critical path towards the Global Operational Concept.

Regional Performance Objective:

Considers operating environments and priorities specific to a regional level.
ATM Community

The aggregate of organizations, agencies or entities that may participate, collaborate and cooperate in the planning, development, use, regulation, operation and maintenance of the air navigation system.
Members of the ATM Community

- Aerodrome community
- Airspace providers
- Airspace users
- ATM service providers
- ATM support industry
- ICAO
- Regulatory authorities
- States
The seven ATM concept components

ATM System: A Holistic Entity

Disaggregated for discussion and role understanding

Complex Interaction

AOM — Airspace organization and management
DCB — Demand/capacity balancing
AO — Aerodrome operations
TS — Traffic synchronization
CM — Conflict management
AUO — Airspace user operations
ATM SDM — ATM service delivery management

The ATM system needs to be disaggregated to understand the sometimes complex interrelationship between its components.

The ATM system cannot, however, function without all of its components. The components must be integrated.

All components must be present in the ATM system.
Seven Concept Components

- Airspace organization and management (AOM)
- Aerodrome operations (AO)
- Demand and capacity balancing (DCB)
- Traffic synchronization (TS)
- Airspace user operations (AUO)
- Conflict management (CM)
- ATM service delivery management (SDM)
Airspace Organization and Management (AOM)

- All airspace will be the concern of ATM and will be a useable resource.
- Any restriction on the use of any particular volume of airspace will be considered transitory.
- Airspace management will be dynamic and flexible.
Aerodrome Operations (AO)

- Runway occupancy time will be reduced
- The ability to safely manoeuvre in all weather conditions
- Precise surface guidance to and from a runway
- The position and intent of all vehicles and aircraft operating on the manoeuvring and movement areas will be known.
Demand and Capacity Balancing (DCB)

Through CDM at the strategic stage, assets will be optimized.

Through CDM at the pre-tactical stage, adjustments will be made to assets, resource allocations, projected trajectories, airspace organization, and allocation of entry/exit times.

At the tactical stage, dynamic adjustments to the organization of airspace to balance capacity; dynamic changes to the entry/exit times.
Traffic Synchronization (TS)

- Dynamic 4-D trajectory control and negotiated conflict-free trajectories
- Choke points will be eliminated
- Optimisation of traffic sequencing will achieve maximization of runway throughput.
Airspace User Operations (AUO)

- ATM data will be fused for an airspace user’s situational awareness and conflict management.
- Airspace user operational information will be made available to the ATM system.
- Individual aircraft performance, flight conditions, and available ATM resources will allow dynamically-optimised 4-D trajectory planning.
Conflict Management (CM)

- Collaborative decision making
- Aircraft should be designed with the ATM system as a key consideration.
ATM Service Delivery Management (SDM)

- Principles include:
- Trajectory, profile, and aircraft or flight intent
- Management by trajectory
- Clearance
Guiding Principles in six main areas:

- Safety
- Humans
- Technology
- Information
- Collaboration
- Continuity
Guiding Principles: Safety

- A safe system is the highest priority in air navigation system
- A comprehensive process for safety management will be implemented, enabling the ATM community to achieve efficient and effective outcomes
Humans will play an essential and, where necessary, central role in the global air navigation system.

Humans are responsible for managing the system, monitoring its performance and intervening, when necessary, to ensure the desired system outcome.

Due consideration to human factors must be given in all aspects of the system.
Guiding Principles: Technology

- No reference to any specific technology
- Openness to new technologies
- CNS systems and advanced information management technology will functionally combine the ground-based and airborne system elements into a fully integrated interoperable and robust air navigation system
- Flexibility across regions, homogeneous areas and major traffic flows
Guiding Principles: Information

The ATM community will depend extensively on the provision of timely, relevant, accurate, accredited and quality-assured information to collaborate and make informed decisions. Sharing information on a system-wide basis will allow the ATM community to conduct its business and operations in a safe and efficient manner.
Guiding Principles: Collaboration

- Strategic and tactical collaboration in which the appropriate members of the ATM community will participate in the definition of the types and levels of service.
Guiding Principles: Continuity

The realization of the concept requires contingency measures to provide maximum continuity of service in the face of major outages, natural disasters, civil unrest, security threats or other unusual circumstances.
Eleven Expectations / KPA’s (in alphabetical order)

- Access and Equity
- Capacity
- Cost-effectiveness
- Efficiency
- Environment
- Flexibility
- Global interoperability
- Participation by the ATM community
- Predictability
- Safety
- Security
Access and Equity

- A global air navigation system should provide an operating environment that ensures that all airspace users have right of access to the air navigation system resources needed to meet their specific operational requirements and that the shared use of airspace by different users can be achieved safely.

- The global air navigation system should ensure equity for all users that have access to a given airspace or service.
Capacity

- The global air navigation system should exploit the inherent capacity to meet airspace user demands at peak times and locations while minimizing restrictions on traffic flow.

- To enable future growth, capacity must increase, while ensuring that there are no adverse impacts on safety, and giving due consideration to the environment.
Cost-effectiveness

- The air navigation system should be cost-effective, while balancing the varied interests of the ATM community.
- The cost of service to airspace users should always be considered when evaluating any proposal to improve ATM service quality or performance.
- ICAO policies and principles regarding user charges should be followed.
Efficiency

- Addresses the operational and economic cost-effectiveness of gate-to-gate flight operations from a single-flight perspective.

- In all phases of flight, airspace users want to depart and arrive at the times they select and fly the trajectory they determine to be optimum.
The air navigation system should contribute to the protection of the environment by considering noise and emissions in the implementation and operation of the global air navigation system.
Flexibility

Addresses the ability of all airspace users to modify flight trajectories dynamically and adjust departure and arrival times, thereby permitting them to exploit operational opportunities as they occur.
Global interoperability

The air navigation system should be based on global standards and uniform principles to ensure the technical and operational interoperability of ATM systems and facilitate homogeneous and non-discriminatory global and regional traffic flows.
Participation by the ATM community

The ATM community should have a continuous involvement in the planning, implementation and operation of the system to ensure that the evolution of the global ATM system meets the expectations of the community.
Predictability

- Refers to the ability of airspace users and ATM service providers to provide consistent and dependable levels of performance.

- Predictability is essential to airspace users as they develop and operate their schedules.
Safety

- Safety is the highest priority in aviation
- ATM plays an important part in ensuring overall aviation safety
- Uniform safety standards and risk and safety management practices should be applied systematically to the air navigation system.
Adequate security is a major expectation of the ATM community and of citizens. The air navigation system should therefore contribute to security, and ATM as well as ATM-related information should be protected against security threats.
Key Conceptual Changes

Three Conflict Management Layers

- Strategic conflict management
- Separation provision
- Collision avoidance
Key Conceptual Change

Strategic Conflict Management

- Achieved through airspace organization and management, demand and capacity balancing and traffic synchronization

- “Strategic” is used here to mean “in advance of tactical”

- Strategic conflict management measures aim to reduce the need to apply the second layer — separation provision
The tactical process of keeping aircraft away from hazards by at least the appropriate separation minima

Only used when strategic conflict management (i.e. airspace organization and management, demand and capacity balancing and traffic synchronization) cannot be used efficiently

The separator is the agent responsible for separation provision for a conflict and can be either the airspace user or a separation provision service provider.
Key Conceptual Change

Collision avoidance

- The third layer of conflict management
- Must activate when the separation mode has been compromised
- Collision avoidance is not part of separation provision
- Collision avoidance systems are not included in determining the calculated level of safety required for separation provision
- Collision avoidance systems will, however, be considered as part of ATM safety management.
Aeronautical Information Management (AIM)

- AIM will ensure the cohesion and linkage between the seven concept components
  - Provides quality-assured and timely information to support ATM operations
  - An information-rich environment will be key to the concept.
Meteorological information

Will be tailored to meet ATM requirements in terms of content, format and timeliness

The main benefits of meteorological information, for the ATM system, will be related to the following:

1. to optimize real time flight trajectory planning and prediction, thus improving the safety and efficiency of the ATM system;

2. increased availability of meteorological information (air-reports) from on-board meteorological sensors will contribute to improving forecast meteorological information and the display of real-time information; and

3. meteorological information will contribute to minimizing the aviation impact on environment.
Other essential services

ATM system will provide information to, or may receive information from other essential activities as:

- **Air defence systems and military control systems** will need timely and accurate information on flights and ATM system intents. They will be involved in airspace reservations and notification of air activities and in enforcing measures related to security.

- **Search and rescue organizations** will need timely and accurate search and rescue information on aircraft in distress and accidents because such information plays an important role in the quality of the search function.

- **Aviation accident/incident investigation authorities** will need to exploit recordings of flight trajectory data and ATM actions.

- **Law enforcement (including customs and police authorities)** will need flight identification and flight trajectory data, as well as information about traffic at aerodromes.

- **Regulatory authorities** will need to implement the regulatory framework within the legal powers given to them and to monitor the safety status of the ATM system.
Expected Benefits in General

- Improved safety management processes will ensure that safety performance remains the highest priority.
- Business cases will ensure efficient and cost-effective air navigation system developments and operations.
- Collaborative decision making and system-wide ATM information will enable airspace user participation in balancing the demands on the air navigation system, thereby providing flexibility and predictability.
Expected Benefits Specifically

- All airspace will be available as a usable resource, resulting in improved access, increased opportunity for user-preferred trajectories and, through community cooperation, increased capacity.
Expected Benefits Specifically

- Improved surface management of the aerodrome will provide predictable departure and gate-arrival times, thereby improving overall air navigation system predictability and subsequent capacity.
Expected Benefits Specifically

- Improved information exchange and cooperation within the ATM community will maximize system capacity
- Improved all-weather operations will maintain maximum capacity
- Improved information concerning demand and system capabilities will prevent system overloads, ensuring manageable workloads
Expected Benefits Specifically

- Provision of accredited, quality-assured and timely information will allow an informed decision-making process.
- The ATM community will contribute to the protection of the environment by taking into consideration the consequences of airspace activities.
Summary

- CNS/ATM systems was a first step
- We needed a vision: the operational concept
- Concept consists of 7 integrated components
- The future system will be an information rich environment, that solves most problems strategically, through a collaborative process
- Ongoing work consists of developing
  - Flight and Flow Information for a Collaborative Environment (FF-ICE)
  - Detailed concept components for SARPS development

- Global Performance Objectives will achieve measurable progress towards achievement of the vision of the ATM Operational Concept
THANK YOU
Objective

To present the concept and the steps towards the implementation of the future ATM system.
Presentation Outline

- History and Background
- ATM Community
- Concept components
- Guiding principles
- Expectations / KPA’s
- Key Conceptual Changes
- Information Management
- Expected benefits
- Summary
History and Background

- FANS
- Tenth Air Navigation Conference
- CNS/ATM Systems
- Global Coordinated Plan for Transition to ICAO CNS/ATM Systems
- Planning and Implementation Regional Groups embarked on an extensive effort
- SARPs, PANS, Guidance material
- Eleventh Air Navigation Conference
- ICAO’s commitment to adopt a business process approach.
Vision statement

To achieve an interoperable global air traffic management system for all users during all phases of flight, that

• meets agreed levels of safety
• provides for optimum economic operations
• is environmentally sustainable and
• meets national security requirements.
Global ATM Operational Concept

- The global ATM operational concept is a vision that;
  ✓ describes how an integrated global ATM system should operate
  ✓ describes what is envisaged on the basis of services
  ✓ describes how the services form an integrated system
  ✓ utilizes an information rich environment, that solves most problems strategically, through a collaborative process
  ✓ provides States and industry with clearer objectives for the design and implementation of ATM and supporting CNS systems
Transition to a Performance Based Air Navigation System

- Technology is not an end in itself
- Requires a comprehensive concept for an integrated, global air navigation system, based on clearly-established operational requirements
- Concept endorsed by the 11th Air Navigation Conference
- Strategic Guidance Established
  - ATM system requirements
  - Transition strategy
  - Performance framework
- Next steps
  - Global Performance Objectives to achieve measurable progress towards achievement of the vision of the concept
Performance Objectives

- **Global Performance Objective:**
  Improvements to the Air Navigation System that are on the critical path towards the Global Operational Concept.

- **Regional Performance Objective:**
  Considers operating environments and priorities specific to a regional level.
ATM Community

The aggregate of organizations, agencies or entities that may participate, collaborate and cooperate in the planning, development, use, regulation, operation and maintenance of the air navigation system.
Members of the ATM Community

- Aerodrome community
- Airspace providers
- Airspace users
- ATM service providers
- ATM support industry
- ICAO
- Regulatory authorities
- States
The seven ATM concept components

ATM System: A Holistic Entity

The ATM system needs to be disaggregated to understand the sometimes complex interrelationship between its components.

ATM System: A Holistic Entity

Disaggregated for discussion and role understanding

AOM — Airspace organization and management
DCB — Demand/capacity balancing
AO — Aerodrome operations
TS — Traffic synchronization
CM — Conflict management
AUO — Airspace user operations
ATM SDM — ATM service delivery management

Complex Interaction

Information management

All components must be present in the ATM system

The ATM system cannot, however, function without all of its components. The components must be integrated.
Seven Concept Components

- Airspace organization and management (AOM)
- Aerodrome operations (AO)
- Demand and capacity balancing (DCB)
- Traffic synchronization (TS)
- Airspace user operations (AUO)
- Conflict management (CM)
- ATM service delivery management (SDM)
Guiding Principles in six main areas:

- Safety
- Humans
- Technology
- Information
- Collaboration
- Continuity
Eleven Expectations / KPA’s (in alphabetical order)

- Access and Equity
- Capacity
- Cost-effectiveness
- Efficiency
- Environment
- Flexibility
- Global interoperability
- Participation by the ATM community
- Predictability
- Safety
- Security
Key Conceptual Changes

Three Conflict Management Layers

- Strategic conflict management
- Separation provision
- Collision avoidance
Key Conceptual Change

Strategic Conflict Management

- Achieved through airspace organization and management, demand and capacity balancing and traffic synchronization
- “Strategic” is used here to mean “in advance of tactical”
- Strategic conflict management measures aim to reduce the need to apply the second layer — separation provision
Key Conceptual Change

Separation Provision

- The tactical process of keeping aircraft away from hazards by at least the appropriate separation minima
- Only used when strategic conflict management (i.e. airspace organization and management, demand and capacity balancing and traffic synchronization) cannot be used efficiently
- The separator is the agent responsible for separation provision for a conflict and can be either the airspace user or a separation provision service provider.
Collision avoidance

- The third layer of conflict management
- Must activate when the separation mode has been compromised
- Collision avoidance is not part of separation provision
- Collision avoidance systems are not included in determining the calculated level of safety required for separation provision
- Collision avoidance systems will, however, be considered as part of ATM safety management.
Aeronautical Information Management (AIM)

AIM will ensure the cohesion and linkage between the seven concept components

- Provides quality-assured and timely information to support ATM operations

- An information-rich environment will be key to the concept.
Meteorological information

Will be tailored to meet ATM requirements in terms of content, format and timeliness

The main benefits of meteorological information, for the ATM system, will be related to the following:

1. to optimize real time flight trajectory planning and prediction, thus improving the safety and efficiency of the ATM system;

2. increased availability of meteorological information (air-reports) from on-board meteorological sensors will contribute to improving forecast meteorological information and the display of real-time information; and

3. meteorological information will contribute to minimizing the aviation impact on environment.
Other essential services

ATM system will provide information to, or may receive information from other essential activities as:

- **Air defence systems and military control systems** will need timely and accurate information on flights and ATM system intents. They will be involved in airspace reservations and notification of air activities and in enforcing measures related to security.

- **Search and rescue organizations** will need timely and accurate search and rescue information on aircraft in distress and accidents because such information plays an important role in the quality of the search function.

- **Aviation accident/incident investigation authorities** will need to exploit recordings of flight trajectory data and ATM actions.

- **Law enforcement (including customs and police authorities)** will need flight identification and flight trajectory data, as well as information about traffic at aerodromes.

- **Regulatory authorities** will need to implement the regulatory framework within the legal powers given to them and to monitor the safety status of the ATM system.
Expected Benefits in General

- Improved safety management processes will ensure that safety performance remains the highest priority.
- Business cases will ensure efficient and cost-effective air navigation system developments and operations.
- Collaborative decision making and system-wide ATM information will enable airspace user participation in balancing the demands on the air navigation system, thereby providing flexibility and predictability.
Expected Benefits Specifically

- All airspace will be available as a usable resource, resulting in improved access, increased opportunity for user-preferred trajectories and, through community cooperation, increased capacity
Expected Benefits Specifically

- Improved surface management of the aerodrome will provide predictable departure and gate-arrival times, thereby improving overall air navigation system predictability and subsequent capacity
Expected Benefits Specifically

- Improved information exchange and cooperation within the ATM community will maximize system capacity.
- Improved all-weather operations will maintain maximum capacity.
- Improved information concerning demand and system capabilities will prevent system overloads, ensuring manageable workloads.
Expected Benefits Specifically

- Provision of accredited, quality-assured and timely information will allow an informed decision-making process.

- The ATM community will contribute to the protection of the environment by taking into consideration the consequences of airspace activities.
Summary

- CNS/ATM systems was a first step
- We needed a vision: the operational concept
- Concept consists of 7 integrated components
- The future system will be an information rich environment, that solves most problems strategically, through a collaborative process
- Ongoing work consists of developing
  - Flight and Flow Information for a Collaborative Environment (FF-ICE)
  - Detailed concept components for SARPS development
- Global Performance Objectives will achieve measurable progress towards achievement of the vision of the ATM Operational Concept
THANK YOU
SUMMARY
One and a half years after the implementation of the AFI RVSM between FL 290 to FL410 the Controllers in the region have had various experiences; this paper thus highlights these experiences.

1. Introduction

1.1 On 25th September 2008 the AFI region implemented RVSM in the airspace between FL290 and FL410. This airspace became restricted to RVSM approved aircraft only except for those aircraft which would climb or descend unrestricted to/from levels above FL410.

1.2 This implementation was as a result of close monitoring and consultations by a team of experts that included ARMA, ICAO, IATA, ATNS, Kenya CAA, ASECNA, IFALPA and IFATCA. This AFI RVSM working group with the blessings from APIRG (Conc 16/38) had approved the date of 25th September 2008 for the implementation of the RVSM in the AFI region with approval from APIRG 16th meeting held in Rwanda on 19-23 November 2007. At the AFI RVSM TF 14th meeting the States had indicated that the National Safety Plans (NSP), the CNS infrastructure to support the implementation of RVSM, The Letters of Agreement/ Letters of Procedures (LOA/LOP) between States and adjacent FIRs, had all been completed and the Pre-Implementation Safety Case (PISC) for the region had been completed and would be sent to the ICAO ANC for approval by June of 2008.

1.3 As the days drew closer to the implementation date, the AFI RVSM TF co-opted IFATCA into the Project Management Team (PMT). It was the mandate of this team to ensure that all the Tasks agreed on for the safe implementation was completed by the target date, and any difficulties resolved or contingencies put in place to deal with them.
2. Discussion

2.1 At the time of implementation IFATCA had expressed concern that although the States had reported that all the necessary safety targets were met some ATC centers were not ready for the implementation, some controllers were not very conversant with the requirements and new ATM systems were yet to be validated. Some States had raised concern that their Communication infrastructure would not be ready by 25th September 2008 among them Angola and DRC. These concerns the PMT believed would be overcome in the following few weeks before implementation and therefore the target date of 25th September 2008 was accepted at the RVSM TF 14th meeting in Nairobi on 26th-28th May 2008. Due to the concerns expressed on individual unit readiness, IFATCA embarked on intense monitoring of the States preparation through the Member Associations.

2.2 Following the implementation, IFATCA member associations have provide the necessary feedback. In general the air traffic controllers in the region have been happy with the extra six flight levels created by the implementation of RVSM in the region. These extra levels have eased the congestion that were initially experienced on optimum levels like FL310-FL370 and created less workload for the controllers in the area of coordination.

2.3 A number of ATC units reports difficulties with handling State aircraft. While a number of state aircraft are RVSM approved some are not. The AFI region handles a large volume of state aircraft and the requirement to provide 2000 feet separation between them and other traffic over stretch the airspace. In a region where large areas are not covered by surveillance equipment it is essential that information is received concerning the status of all flight; this is not happening as required.

2.4 Cases are sometimes not reported of Non RVSM approved flights entering RVSM airspace without authority; this happened a lot in the early part of implementation. Flight plans sometimes indicated that aircraft were RVSM approved and yet later it would be realized that this was not the case; the assumption that certain types of aircraft have the required capability have led to most of these breaches.

2.5 Although Communication was improved in the region before implementation, today communication failures have been in the increase in the region. Whereas this is a widespread problem in the region, Controllers mainly in the west and central African region are more affected; they continue to work with very limited communication facilities. Coordination between units is sometime very difficult, resulting into a number of ATC incidents in the region.

2.6 Due to the nature of provision of Air traffic services, certain types of incidents go un-reported because they are considered as normal operations; a good example is large altitude deviations due to turbulence. For this reason it is important to note that Safety case analysis may not reflect the true picture. It is important that all incidents irrespective of how small it is be reported.
2.7  Also reported is that in **TCAS RA cases and Turbulence conditions**, flight levels are changed with more than 500 feet; often a full flight level is changed e.g. from FL330 to FL350 or from FL330 to FL340 e.t.c; this sometimes without controllers being aware of the magnitude of change in flight level.

3.  **Conclusion**

3.1  The deficiencies that are still being realized in the AFI region are of great concern to the controllers. There is urgent need to address Communication deficiencies, especially between ground units for both RVSM and general safety of operations.

3.2  The number of non-RVSM aircraft that operate in RVSM airspace (whether State aircraft or incorrect action or emergency traffic of non-RVSM non-State aircraft) must be monitored keenly and on-going assessment made on whether the safety of exclusive RVSM airspace continues to be valid.

3.3  Pilot and controller education must continue on procedures in RVSM for dealing with turbulence (including the suspension of 1000 foot separation), and how to respond to TCAS RAs.

3.4  The reporting of events (what to report, and reporting procedures, etc), especially reporting of Large Height Deviations must be encouraged.

3.5  IFATCA would like to stress that the TAG should continue to address on-going issues.

4.  **Recommendation**

4.1  IFATCA recommends that this presentation be accepted as information paper.
Threat and Error Management (TEM) & Normal Operations Safety Survey (NOSS) – Essential SMS Tools

Chris Henry, Ph.D.
NOSS Collaborative
henry@nosscollective.org
Overview

- Normal Operations Safety Survey (NOSS)
  - History and background
  - Success Factors – the 10 characteristics
  - Threat and Error Management (TEM)
  - Case studies: Applications of NOSS data
What is NOSS?

- Proactive (Predictive) safety data collection tool
- Over-the-shoulder observations during normal shifts
- An evaluation of the larger ATC system, not the controller
- Focuses on daily challenges & how they impact controllers and & the ATC system
- Based on objective data, not opinions
- Provides data on strengths and weaknesses
- Is a period/cyclic program, rather than continuous (NOSS is envisioned to be conducted every 3-4 years)
TEM, LOSA & NOSS
Background & Development
<table>
<thead>
<tr>
<th>LOSA Airlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeromexico</td>
</tr>
<tr>
<td>Alaska Airlines</td>
</tr>
<tr>
<td>Air Canada</td>
</tr>
<tr>
<td>Air Nelson (New Zealand)</td>
</tr>
<tr>
<td>Air Freight New Zealand</td>
</tr>
<tr>
<td>Air New Zealand</td>
</tr>
<tr>
<td>Air Transat (Canada)</td>
</tr>
<tr>
<td>ANA</td>
</tr>
<tr>
<td>Asiana (South Korea)</td>
</tr>
<tr>
<td>Braathens (Norway)</td>
</tr>
<tr>
<td>Cathay Pacific</td>
</tr>
<tr>
<td>China Airlines</td>
</tr>
<tr>
<td>COPA (Panama)</td>
</tr>
<tr>
<td>Continental</td>
</tr>
<tr>
<td>Continental Express</td>
</tr>
<tr>
<td>Continental Micronesia</td>
</tr>
<tr>
<td>Delta</td>
</tr>
<tr>
<td>DHL</td>
</tr>
<tr>
<td>EVA Air (Taiwan)</td>
</tr>
<tr>
<td>Emirates</td>
</tr>
<tr>
<td>Frontier Airlines (United States)</td>
</tr>
<tr>
<td>Japan Airlines</td>
</tr>
<tr>
<td>JetBlue (United States)</td>
</tr>
<tr>
<td>QANTAS</td>
</tr>
<tr>
<td>Malaysian Airlines</td>
</tr>
<tr>
<td>Mexicana</td>
</tr>
<tr>
<td>Mount Cook Airlines (New Zealand)</td>
</tr>
<tr>
<td>Regional Express (Australia)</td>
</tr>
<tr>
<td>Saudi Arabian Airlines</td>
</tr>
<tr>
<td>Singapore Airlines</td>
</tr>
<tr>
<td>Singapore Airlines Cargo</td>
</tr>
<tr>
<td>Silk Air (Singapore)</td>
</tr>
<tr>
<td>TACA (El Salvador)</td>
</tr>
<tr>
<td>TACA Peru</td>
</tr>
<tr>
<td>TAP Portugal</td>
</tr>
<tr>
<td>Thomas Cook (United Kingdom)</td>
</tr>
<tr>
<td>UNI Air (Taiwan)</td>
</tr>
<tr>
<td>US Airways</td>
</tr>
<tr>
<td>Westjest (Canada)</td>
</tr>
</tbody>
</table>
TEM & NOSS Development

- The ICAO NOSS Study Group
  - Airservices Australia
  - Airways New Zealand
  - EUROCONTROL
  - Federal Aviation Administration
  - International Civil Aviation Organization
  - International Federation of Air Traffic Controllers’ Associations’
  - NAV CANADA
  - United Kingdom Civil Aviation Authority
  - DFS (Germany)
  - University of Texas (Dr. Henry was the University representative to the study group)

- ICAO Publications
  - Circular 314 – *Threat and Error Management (TEM) in Air Traffic Control*
  - Document 9910 – *The Normal Operations Safety Survey (NOSS)*
NOSS Deployments

- Where has NOSS been deployed
  - Australia
  - Canada
  - New Zealand
  - United States
  - Finland
- NOSS Archive – 1,400+ observations
- Future/Additional deployments
  - South Korea
  - United States
  - Canada
  - New Zealand
  - Australia
  - Middle East
  - Latin America
  - Europe
Contributions to Safety Management
Aviation Safety Envelope
Safety Data Coverage

- Accidents
- Incidents
- Normal Operations

Voluntary Reporting Systems

NOSS

Mandatory Incident Reports

Accident Investigation
NOSS Success Factors
NOSS Success Factors

- NOSS success is dependent upon methodology and execution

Low controller trust = Low quality data because there will be no differentiation between NOSS and proficiency checks.
NOSS: The Ten Characteristics

1. Over-the-shoulder observations during normal shifts
2. Anonymous, confidential, and non-punitive data collection
3. Joint management / association sponsorship
4. Voluntary Participation
5. Trusted and trained observers
6. Trusted and secure data collection site
7. Systematic data collection instrument
8. Data verification process
9. Data-derived targets for safety enhancement
10. Feedback results to controllers
NOSS Operating Characteristics

1. Over-the-shoulder observations during normal shifts
   - No observations of controllers who are undergoing training / checks
   - No direct feedback to the controller after the observation
   - “Fly on the Wall” principle

2. Anonymous, confidential, and non-punitive data collection
   - No names, operating initials, employee numbers, dates, years experience, or other identifying information
   - Data used for safety purposes only – no punitive actions
   - Observers identity is known only by the third party facilitator
3. Voluntary Participation
   - Controllers have the right to refuse observation

4. Joint management / controller association support
   - Letter signed by senior management and association representatives

5. Trusted and Trained Observers
   - Trust and Credibility
     - Selection process – management / association comfort with observers
     - Diversity of observers increases buy-in
   - Training
     - Theoretical background, observation protocols
     - Practice, feedback and calibration
6. Systematic data collection instrument
   - No judgments – observers record data based on TEM events

7. Trusted and secure data collection site
   - Third party or controller association gatekeeper
   - Controllers, observers and management must all be comfortable with the data collection site

8. Data verification process
   - TEM data checked to ensure coding accuracy and consistency with procedures
   - Data analysis does not begin until verification has been completed
9. **Data-derived targets for safety enhancement**
   - Serve as benchmarks for safety change
   - Initial NOSS, safety change process, follow-up NOSS

10. **Feedback results to controllers**
    - Results summarized for controllers
    - Information on how organization intends to respond to the data
NOSS Defined

- The 10 characteristics that differentiate NOSS (LOSA) from other methodologies have been endorsed by the:
  - International Civil Aviation Organization
  - International Air Transport Association
  - International Federation of Airline Pilots’ Associations’
  - International Federation of Air Traffic Controllers’ Associations’
  - Federal Aviation Administration
  - The NOSS Collaborative
  - The LOSA Collaborative
  - US Airline Pilots Association
  - University of Texas

- NOSS must have all ten characteristics, otherwise it is not NOSS!
What do we look for?
Threat and Error Management
Threats

- **Threats**: Events or errors that occur beyond the influence of the observed air traffic controller, that increase operational complexity, and which must be managed to maintain safety margins.
Threats – Radar Environment

- Equipment malfunctions
- Military activity
- Frequency coverage
- Readback errors
- Airspace design
- Automation anomalies
- Turbulence
- Noise

- Similar call signs
- Weather
- Maintenance
- Restricted airspace
- Altitude deviations
- Errors by other controllers
- Pilot errors
Errors: Actions or inactions by the air traffic controller that lead to deviations from organisational or controller intentions or expectations
Errors – Radar Environment

- Late coordination
- Information not updated
- Frequency change error
- Altitude instruction error
- Checklist not used
- Did not pass weather to aircraft
- Strip writing error
- Automation entry error
- Clearance instruction error
- Phraseology
- Hearback error
- No coordination
- Incomplete briefing
- Information not updated
- Automation entry error
- Did not pass weather to aircraft
- Strip writing error
- Late coordination
- Frequency change error
- Altitude instruction error
- Checklist not used
- Did not pass weather to aircraft
- Strip writing error
- Automation entry error
- Clearance instruction error
- Phraseology
- Hearback error
- No coordination
- Incomplete briefing
Undesired States

- **Undesired States**: Operational conditions where an unintended traffic situation results in a reduction in margins of safety
Aviation Safety Envelope

Accidents

Incidents

Normal Operations

Safety
Safety Data Coverage
Case Study 1 – Enhancing Training (& a RVSM finding)
NOSS Finding

- There were numerous instances of non-RVSM aircraft being cleared into the RVSM stratum (in contravention of procedures). Additionally, there was an instance in which coordination was poorly effected in relation to a non-RVSM aircraft.

Response to finding

- Ensuing discussions came to the conclusion that controllers may not fully appreciate the implications of non-RVSM aircraft in the RVSM stratum.
- A component on RVSM operations was included in fresher training.
Case Study 2 – Relation to Incident Data
Problem: An elevated number of incidents were attributable to "Hillside" controllers

- **Incidents**
  - Aircraft handed off at altitudes other than what was coordinated
  - TCAS RA – aircraft were not vertically separated

- **Incident investigations**
  - Events were occurring because of differences between the cleared Flight Level of aircraft and what the controller had entered into the electronic strip.

- The number of these incidents varied greatly from month to month
NOSS and Incident Data

- Did NOSS data show similar findings?
  - Yes, an elevated number of Undesired States were observed in Hillside Airspace compared to other sectors.
  - These Undesired States were an “inaccurate representation of traffic”, which was the same factor noted in the incident investigations

- What additional information did NOSS provide?
  - The underlying practices/behaviors that led to the incidents were identified
  - Errors – Controllers were updating (pre-loading) the electronic strip before aircraft were being issued altitude instructions.
Case Study 2 – Runway Safety & Identifying Threats
Vulnerable Runways

- Problem: Monitoring runway activity is critical to preventing runway incursions and maintaining safety.
- NOSS Findings:
  - Controllers were not scanning runways prior to issuing takeoff and landing clearances.
  - Controllers were not spending enough time monitoring aerodrome movements.
Why were controllers not monitoring aerodrome movements?

- Were the controllers being irresponsible? NO!
- Threats: controllers were encountering threats that led to “heads down” time instead of monitoring aerodrome movements
  - Unnecessary automated messages
  - Flight Data Progress Strip (FDPS) distribution procedures
- Safety Improvements
  - Create a software filter to eliminate unnecessary messages
  - Change the procedure so the assistant sorts the FDPS instead of the aerodrome controller
Case Study 2 – The Predictive/Unexpected Finding!
The Unexpected Finding

- NOSS Findings: The ACC had a lot of frequency change issues in comparison to other NOSS Archive ACCs
  - Aircraft were not being given frequency changes by the prescribed locations
  - Controllers accepting the handoffs often did not realize that communication had not been established
  - In some instances, these aircraft were conflicting with other aircraft.

- The extent of this issue was a surprise!
- A highly publicized incident (at another ACC) brought this incident to attention towards the end of the NOSS data collection period
The Unexpected Finding

- Solutions discussed by NOSS team
  - Observers identified “best practices” utilized by controllers to ensure they knew which aircraft were on frequency. Controllers should have to use one of the identified best practices to indicate which aircraft were on frequency.

- Solutions implemented as a result of the incident
  - Controllers must use a strategy to indicate which aircraft were on frequency.
Case Study 5 – Informing Airspace Design
Problem: The “BAY” sector had a reputation of being an unstructured and challenging piece of airspace, but there was little data from the SMS to support this reputation.

NOSS data supported the reputation and provided some details:

- More threats, mismanaged threats, errors, and undesired states in Bay than other sectors.
- Traffic conflicts, parachute activity, training aircraft, little airspace for vectoring or solving problems.
- Impartial observers agree, the sector is a mess!
One sector in particular that was previously recognized as being unstructured, and containing a high number of threats was confirmed by the NOSS data to the point that a formal review was initiated. I would have to say it was not NOSS alone that lead to the review, but the factual information it provided gave considerable weight that lead to the final decision. Since the review the sector has undergone some wide ranging changes including improved procedures for controllers working the sector.

-- Provided by the BAY Manager
Fixing the shortcomings in BAY sector

- Solutions suggested (and adopted) by staff:
  - An area was dedicated for parachute activity that reduced demands on controllers
  - A circular flow structure was introduced that minimized conflicts and complexity
  - Confiness of controlled airspace expanded to give more options/flexibility to controller
  - A follow-up NOSS in 2008 (1st NOSS was in 2005) indicated that the airspace changes were largely successful in reducing complexity
Other Examples of Informing Airspace Design

- NOSS findings have been used to:
  - Reduce complexity in Vancouver area airspace during a major re-design of the airspace surrounding the city
  - Prioritize the development of STARs for airports that did not yet have STARs
    - Airports with more movements were to receive STARs first.
    - NOSS data showed the impact of not having STARs was greater at some of the airports with fewer movements – so these airports received STARs first.
Position Handovers - Improvements

- How can briefings be improved?
- The typical way of doing briefings
  - Both controllers are responsible for the briefing.....
  - BUT, in practice the outgoing controller tells the incoming controller what they need to know
  - The incoming controller often has a passive role
- The Challenge and Response Method
  - Incoming controller asks questions and the outgoing controller responds
  - More interactive
  - Best practice identified at Minneapolis ACC
Case Study 6 – Exchanging Information with Airlines
Exchanging Information with Airlines

- Issue: Controllers are usually the largest sources of threats to pilots
- Issue Part II: Pilots are usually the largest source of threat to controllers
- There could be great benefit in airlines and ATC providers exchanging LOSA/NOSS information regarding the impact they are having on one another
Exchanging Information with Airlines - Examples

- Pilots were having difficulty complying with a SID at a major airport
  - NOSS Data – Pilots were not always able to comply with a particular SID
  - LOSA Data – Pilots were having difficulty making SID restrictions; aircraft type and weight were a factor
  - The SID was re-designed to enhance flight crew ability to comply

- Similar call signs
Case Study 7 – The Value of Objective Data
The greatest benefit of the project was getting documented, analyzed data on most of the “small” things many controllers were already aware of. The main threat in our NOSS was primarily noise and bad acoustics in the operations room. This has been the topic of coffee-table discussions for as long as I remember; now it’s on paper as a real problem. Also, by taking a step back and looking at operations, we noticed a few things that nobody had really thought of before. Like the layout of the operations room, causing “traffic flows” and mingling of controllers on their break, in close vicinity to those working.” -- Provided by a NOSS observer and project manager
“As a direct, tangible result of the noise findings, a specialist acoustics planning company was brought in to fix it. Noise damper paneling has been installed in the ceiling and the walls, this work will continue as we switch over to the new controller operating positions and the old ones are removed. This would certainly never have been done without the NOSS findings.” — Provided by a NOSS project manager
Case Study 8 – Position Relief Briefings
Problem: FAA research shows that incidents are more likely to occur shortly after a position handover.

NOSS Findings:

- In multiple NOSSs, there have been vulnerabilities identified surrounding the handover of positions
  - Position relief checklists not being used
  - Incomplete information given during briefings

This has been the most consistent finding across all NOSSs!
Position Handovers - Improvements

- How can briefings be improved?

- Improving Checklists
  - In many places, controllers did not use checklists because they did not see them as relevant
  - Make checklists specific to each sector and focus on what is different in today’s operations
Intangible Benefits of NOSS
Intangible Benefits

Observer Level

- Observers report that they learn a lot from their experience – in some cases, they have changed their own practices
- Greater understanding of how their work impacts other controllers
- Observed best practices are incorporated into their own work/sectors.
- Training instructors have new tools to use with their trainees
Intangible Benefits

- Organizational Level
  - New processes are developed to deal with predictive safety information
  - Previously, organizations were more accustomed to dealing with “crisis” information from failures
  - Enhanced trust from controllers and management working together on a safety project

“NOSS created the trust to pursue other projects such as the Just Culture Initiative at NAV CANADA.”
Greg Myles, CATCA President
IFATCA Regional Meeting (Aruba)
November 2007
Avenues of Improvement - Summary

- **Airspace Re-design**
  - Served as a catalyst to change a piece of highly unstructured and complex piece of airspace that had long been a concern amongst controllers
  - Used to reduce complexity in a major re-design of Vancouver area airspace
  - Prioritize the development of STARs for airports where a lack of STARS had a high observed degree of impact.

- **Procedures**
  - Provisions for splitting sectors or adding a data position
  - Releasing equipment for maintenance
  - Position relief protocols
  - Strip writing procedures

- **Equipment/Workspace**
  - Shortcuts taken by controllers identified
  - Noise dampening panels
  - Special lighting added to sectors with glare problems
Avenues of Improvement - Summary

- **Training**
  - Findings used to enhance refresher or recurrent training
  - Special training modules developed discussing NOSS and Incident data from a TEM perspective

- **Information Exchange**
  - Problematic SID re-designed after consultation with airline
  - Similar call signs – one airline changed the manner in which they numbered their fights
  - Aircraft operating without proper equipment have been identified and paths to remedy this situation have been implemented
  - ATC providers are exchanging ‘best practices’

- **Intangibles – perhaps the most impressive benefit of all!**
  - Observers gain a different perspective
  - ATC organizations have developed new methods of dealing with predictive safety data
  - Enhanced trust between controllers and managers
PISC Overview

Presented by Harry Roberts

Nairobi Kenya

(20th April 2010)
SCOPE

- Summary
- AFI Safety Policy
- PISC
- Aim and Purpose
- AFI RVSM Programme
- Actions Proposed
Implementation of RVSM
- Compliance with international activity relating to RVSM
- Improvement to Safety in the AFI Region environment

Traffic Forecasts

Cost Effective
- Operator efficiency
- Reducing fuel costs by operating closer to optimum trajectory

Additional Flight Levels

Environmentally beneficial.
Established guidelines for implementation activities

The policy elements as reflected in that document were:

- RVSM Functional Hazard Analysis
- Collision Risk Assessment
- National Safety Plans
- AFI RVSM Pre-Implementation Safety Case (PISC)
- AFI RVSM Post-Implementation Safety Case (POSC)
Project Management team resolved to model implementation on Eurocontrol Model.

Three legs:

FHA, CRM, National Safety Plans
AIM AND PURPOSE

✈ RVSM implementation not to contribute to an increase in risk, or incidents within the airspace more than what was currently being experienced, while improving on efficiency, contributing to economic benefit and reducing impact on the environment.
AFI RVSM Programme

Consists of 5 Sub-programmes to ensure and provide evidence on the Compliance of the AFI RVSM Programme which are:

- Functional Hazard Assessment (FHA) report
- Collision Risk Assessment (CRA) report
- National Safety Plans (NSPs)
- Pre Implementation Safety Case (PISC)
- Post Implementation Safety Case (POSC)
<table>
<thead>
<tr>
<th>Algeria</th>
<th>Angola</th>
<th>Benin</th>
<th>Botswana</th>
<th>Burkina Faso</th>
<th>Burundi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameroon</td>
<td>Cabo Verde</td>
<td>Central African Republic</td>
<td>T’schad</td>
<td>Comores</td>
<td>Congo</td>
</tr>
<tr>
<td>Côte d’Ivorie</td>
<td>Djibouti</td>
<td>Democratic Republic of Congo</td>
<td>Egypt</td>
<td>Equatorial Guinea</td>
<td>Eritrea</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Gabon</td>
<td>Ghana</td>
<td>Guinea Bissau</td>
<td>Guinea</td>
<td>Kenya</td>
</tr>
<tr>
<td>Lesotho</td>
<td>Liberia</td>
<td>Libyan Arab Jamahiriya</td>
<td>Madagascar</td>
<td>Malawi</td>
<td>Mali</td>
</tr>
<tr>
<td>Mauritania</td>
<td>Mauritius</td>
<td>Mozambique</td>
<td>Namibia</td>
<td>Niger</td>
<td>Nigeria</td>
</tr>
<tr>
<td>Reunion</td>
<td>Rwanda</td>
<td>Sao Tome</td>
<td>Senegal</td>
<td>Seychelles</td>
<td>Sierra Leone</td>
</tr>
<tr>
<td>Somalia</td>
<td>South Africa</td>
<td>Sudan</td>
<td>Swaziland</td>
<td>Tanzania</td>
<td>The Gambia</td>
</tr>
<tr>
<td>Togo</td>
<td>Uganda</td>
<td>Zambia</td>
<td>Zimbabwe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Seminar:

While the format of the FHA originally conducted, may not compliment the current ICAO hazard assessment, the hazards which were identified during the implementation process are as valid today as they were then and sight should not be lost of the fact that reviews of hazards present in the airspace are as important now as when they were first identified.
END OF PRESENTATION

Thank you

Asante

Merci
RVSM Implementation Safety System Seminar

KENYA RVSM EXPERIENCE INCLUDING OPERATIONS OF STATE AIRCRAFT
• Kenya joined the rest of AFI Region in implementing the RVSM on 25 September 2008. This paper presents Kenya’s experience on RVSM experience including State aircraft operation.
RVSM is an aviation term used to describe the reduction of standard ICAO Conventional Vertical Separation Minima (CVSM) required between aircraft operating between FL290 and FL410 inclusive from 2000FT to 1000FT.

This has effectively increased the number of aircraft that can operate between the above mentioned levels by an additional six flight levels being introduced.
ICAO Tables of Cruising Levels

RVSM

Non RVSM

FL 410
FL 400
FL 390
FL 380
FL 370
FL 360
FL 350
FL 340
FL 330
FL 320
FL 310
FL 300
FL 290

FL 410
FL 390
FL 370
FL 350
FL 330
FL 310
FL 290

Appendix 3 a)  ICAO ANNEX 2  Appendix 3 b)
Kenya’s experience is that before the implementation of RVSM we used to experience a lot traffic delays especially for aircraft that used to operate between Nairobi and Europe. The applicable Flight levels were 310; 350 and 390 for west bound traffic whereas for Eastbound traffic 290, 330 and 370.
• The optimum level used to be 310. It was common for flights to experience 30 or more minutes waiting for availability of optimum level. Alternately the flights would opt for lower levels which would at times even be FL260.

• With the introduction of six additional levels became available and this effectively increased the number of aircraft that can operate between the above mentioned levels by an additional six flight levels. Today ATC delays because of non-availability of levels are minimal.
AIRCRAFT AND OPERATIONS APPROVAL

• In order to sustain the gains and benefits associate with RVSM operation, only aircraft with the required Minimum Aircraft System Performance Specification (MASPS) and approved by their respective States for RVSM operations are permitted to fly in RVSM airspace.

• Non compliant aircraft, excluding State aircraft, are required to operate at or below FL280.
• Our experience is that most aircraft operating in the RVSM airspace do have aircraft operations approval. However occasionally we might have operators who obtain operations approval without getting aircraft RVSM approval.

• We also find the operator who obtain aircraft RVSM aircraft approval and would like to utilize the Aircraft before the information is distributed to respective units including ARMA (Friday evening syndrome).
Large Height Deviation monitoring

- As air Navigation Providers we are required to ensure aircraft do operate at assigned flight levels. Any large height deviation (LHD) by an aircraft is required to be reported to ARMA.

- Our experience is that most flights are operating on assigned levels and LHD deviations has occurred if the ATC Units are not informed of level change by transferring unit.
LHD (cont)

• Our experience is that there are frequent level changes associated with aircraft performance and availability of optimum cruising levels.
• Frequent level changes require effective coordination with adjacent units.
• This has been achieved through rapid and reliable communication links thanks to NAFISAT.
Aircraft operation data

- Kenya recognizes her obligation in collecting and disseminating data to ARMA for analysis and reporting on monthly basis. This requires dedicated staff and also systems that are capable of extracting automatically the required data.

- Kenya has endeavored to do so however we have experienced some challenges as our data is collected and processed manually before transmission to ARMA.

- Kenya expects to overcome this challenge by commission new ATC systems at JKIA within the next one month.
Incidents due RVSM Operations

• Kenya has not experienced any ATC incidents due RVSM operations. However we have had a few ATC incidents/AIRPROX that are associated with:
  • Lack of ATC anticipation/ATC situational awareness/ATC proficiency
  • Lack of coordination between ATS units and cockpit discipline
Abnormal operations that would affect the safe operations in RVSM airspace

• Kenya has not experienced abnormal occurrences that would have direct impact on safety assessment in Kenyan airspace except occasional request by flights to operate at different levels due moderate turbulence.

• We have not had the necessity to suspend RVSM operations.
Aircraft Height Monitoring

• In order to ensure continued safe operation of aircraft in RVSM airspace; aircraft are required to undergo routine height keeping monitoring.

• To date we have 42 Kenyan RVSM approved aircraft. Sixteen (16) of these aircraft especially those that operate regionally have not participated in height monitoring exercise.

• This requires to be addressed. Aircraft operators are required to make arrangements
Objective

To present a brief history related to the development and implementation of RVSM.
Outline

- The Beginning
- The Vertical Separation Panel
- Early Regional Air Navigation (RAN) Meetings
- RGCSP
- Time for development
- Results
1940s: 1,000 feet (300 meters) in all cases except 500 feet (150 meters) when:

- Aircraft are being flown in conditions of flight visibility of less than 3 miles (5km) but not less than 1 mile (1.5 km).
- Aircraft are holding above a well defined top of cloud or other formation during the hours of darkness if the pilot reports indicate the forward visibility is not less than 1 mile (1.5 km).
Aircraft are on flight paths which will cross at or near a reporting point, provided that the aircraft concerned are using the same altimeter setting.

No separation is required for enroute traffic above a well defined top of cloud or other formation if frequent in-flight weather reports indicate a generally unlimited ceiling on top and flight visibility of at least 3 miles (5km). During the hours of daylight, holding aircraft operation under these conditions will require no separation.
The advent of commercial turbo jet aircraft operating at high levels necessitated a reevaluation of the vertical separation minimum.

A Vertical Separation Panel was therefore formed in June 1954.

The Panel identified those factors which were likely to contribute towards the greatest loss of separation and proposed steps that should be taken to reduce or eliminate their influence.
The 1958 RAC/SAR Divisional Meeting

“The vertical separation minimum shall be 305 meters (1000 ft) except that, above a level to be determined on the basis of Regional Air Navigation Agreements, 610 meters (2000 ft) shall be established as the vertical separation minimum. This level should not be higher than an altitude of 8850 meters (29000 ft) or flight level 8850 metric (290).”
The vertical separation minimum between IFR traffic shall be a nominal 300 meters (1000 ft) below an altitude of 8850 meters (29000 ft) or flight level 290 and a nominal 600 meters (2000 ft) at or above this level, except where, on the basis of regional air navigation agreements, a lower level is prescribed for the change to a nominal 600 meters (2000 ft) vertical separation minimum.
That, in view of the importance of vertical separation criteria in the planning of Air Traffic Services for NAT Region, as well as for other regions of high traffic density, the work of the Organization in the field of vertical separation be pursued vigorously to an early conclusion and be presented in a form suitable for early application in regional ATS.
That in view of the importance of vertical separation in the planning of air traffic services particularly in regions of higher traffic density and the desirability of reducing vertical separation intervals above Flight Level 290, work in the field of vertical separation be vigorously pursued by all concerned to an early conclusion and presented to ICAO in a form suitable for early application in ATS planning on a world-wide basis, or, if this is not attainable, at least on a regional basis.
Recommendation - Technical Measures by States and Operators of aircraft intended to be used for operation in that part of the NAT Region where 1000 feet vertical separation is to be applied above FL290:
Ensure as soon as possible that operators are taking all necessary measures for installation, calibration and maintenance of altimeter systems and autopilots in accordance with the latest available methods; and

Assure themselves as soon as possible by means of flight tests, as appropriate, that calibration, maintenance and operating techniques used by the operators are such as to achieve the necessary degree of reliability and accuracy of altimeters and autopilots.
The changeover level was established at FL 290 on a global basis.

At the same time, it was considered that the application of a reduced VSM above FL 290, on a regional basis and in carefully prescribed circumstances, was a distinct possibility in the not too distant future.

Accordingly, ICAO provisions stated that such a reduced VSM could be applied under specified conditions within designated portions of airspace on the basis of regional air navigation agreement.
1970

- World fuel shortages and the resultant rapid escalation of fuel costs

- Growing demand for a more efficient utilization of the available airspace, emphasized the necessity for a detailed appraisal of the proposal to reduce the VSM above FL 290.
DEVELOPMENT OF THE RVSM - WHY SO MUCH INTEREST?

- fuel-burn penalty of about 1 percent for each 1000 ft below optimum cruise altitude
- RVSM was single best thing to do - fuel-burn reduction far outweighed any horizontal plane separation reductions, for example, 30 NM lateral/30 NM longitudinal
- RVSM provides (theoretical) doubling of capacity in same airspace
- achievable without major change to aircraft or ATC system
- 1971 – RGCSP/1
ICAO Review of the General Concept of Separation Panel (RGCSP) (1982): agreed to begin task to determine RVSM technical feasibility

Several States represented in the Panel began individual programs, coordinating efforts within the Panel: Canada, Eurocontrol (France, Germany, Netherlands, United Kingdom), Japan, the former USSR and the United States
REVIEW OF THE GENERAL CONCEPT OF SEPARATION PANEL

- RGCSP/6 (1988): “Recommended that RVSM was technically feasible”

- RGCSP/7 (1990): draft RVSM guidance material was produced - Doc 9574

- ICAO ANC (1990): approved draft guidance material and draft Standards and Recommended Practices (SARPS) to Annex 2

- 1997 – 27 March, First RVSM Implementation
WHY SO LONG?

- Aircraft maintain assigned flight level by sensing and measuring pressure and converting pressure to feet via ICAO Standard Atmosphere
- Errors in the sensing and conversion process not easily estimated
  - observed errors in pressure altitude on flight deck or in SSR Mode C reflect only differences between cleared (or commanded) pressure altitude and pressure altitude actually flown
  - difference between aircraft-measured pressure and constant pressure surface defining flight level is what is needed
- Difference called altimetry system error (ASE)
WHY SO LONG?

- Flight levels (constant pressure) defined by constant pressure surfaces in atmosphere
- Constant pressure surface over a geographic region is not at constant geometric height
  - in general: constant pressure surfaces increase in geometric height from pole to equator
  - in general: in temperate climates, constant pressure surface geometric heights are higher in summer than winter
- To determine errors in altimetry system, need information about geometric height of flight levels and geometric height of aircraft - neither of which is available readily.
Development of the RVSM - The Major Problem

FL 350 = Constant Pressure Altitude

FL 350 Geometric Height
Height Keeping Performance Errors

Aircraft geometric height

Total Vertical Error (TVE) = Altimetry System Error + Assigned Altitude Deviation
= ASE + FTE(AAD)

FL 350 Geometric Height
Operators have found benefits greater and costs less than predicted

ATC units report little difficulty with RVSM procedures

ATC units able to offer more desirable routings

ATC units report RVSM provides more operational flexibility.
WAS IT WORTH IT?
Outline

- The Beginning
- The Vertical Separation Panel
- Early Regional Air Navigation (RAN) Meetings
- RGCSP
- Time for development
- Results
A BRIEF HISTORY OF RVSM

THANK YOU

QUESTIONS?

SAULO JOSÉ DA SILVA
SDASILVA@ICAO.INT
TECHNICAL REVIEW OF RVSM

SAULO SILVA
ATM Section
Air Navigation Bureau, ICAO HQ
April 2010
Objective

To present some technical aspects related to the implementation and safe use of RVSM.
Outline

- General requirements
- Implementation planning
- Aircraft requirements
- System performance monitoring
- Responsibilities
- Challenges
- Example
GENERAL REQUIREMENTS

SAFETY OBJECTIVES
The implementation and use of RVSM is based on the satisfaction of safety objectives

Technical risk – 2.5 \times 10^{-9}

Overall risk - set by regional agreement

Overall risk – 5.0 \times 10^{-9}
GENERAL REQUIREMENTS

- Reduction in the level of risk of collision resulting from operational errors and in-flight contingencies in RVSM airspace.

- To institute measures to ensure that the risk due to operational errors and in-flight contingencies does not increase following the reduction of vertical separation.

- To guarantee that the implementation of RVSM will not adversely affect overall airspace safety.
GLOBAL SYSTEM PERFORMANCE SPECIFICATION

- Defines the height-keeping performance necessary to meet the safety goal for RVSM technical risk

  a) a **passing frequency equal to 2.5** opposite-direction passings per aircraft flight hour;

  b) a standard deviation of lateral path-keeping error equal to 550 m (0.3 NM); and

  c) a probability that two aircraft will lose procedural vertical separation of RVSM value, \( Pz(1000) \), equal to \( 1.7 \times 10^{-8} \)
GENERAL REQUIREMENTS

GLOBAL HEIGHT-KEEPING PERFORMANCE SPECIFICATION

Required $P_z(1\ 000)$ value of the global system performance specification be met

a) the proportion of height-keeping errors beyond 90 m (300 ft) in magnitude is less than $2.0 \times 10^{-3}$;

b) the proportion of height-keeping errors beyond 150 m (500 ft) in magnitude is less than $3.5 \times 10^{-6}$;

c) the proportion of height-keeping errors beyond 200 m (650 ft) in magnitude is less than $1.6 \times 10^{-7}$;

and

d) the proportion of height-keeping errors between 290 m and 320 m (950 ft and 1050 ft) in magnitude is less than $1.7 \times 10^{-8}$
GENERAL REQUIREMENTS

The mentioned requirements have been the basis for the development of the RVSM minimum aircraft system performance specification (MASPS).
The implementation planning

CONSIDERATIONS

- The introduction of RVSM is based on a regional air navigation agreement.

- All aircraft operating within the designated airspace must meet the height-keeping performance.
The implementation planning

Factors considered

- Ability of the ATS infrastructure to fully support RVSM, including examination of the equipment and procedures necessary to achieve the goal of the elimination of operational errors;

- State procedures for ensuring that aircraft on their registry, or for which they have a responsibility because they are the State of the Operator, do not operate in RVSM airspace unless approved to do so.
OPERATING CONDITIONS

- Transition procedures
- IFR
- Contingency plans
- Strategic ATC procedures when system performance monitoring indicates that established tolerances are exceeded
IMPLEMENTATION STRATEGY

- Identified the need for RVSM
- Preliminary assessment of system safety
- Plan and preparation
- Verification phase
- Operational use of RVSM
OPERATIONAL USE OF RVSM

- It will be necessary to ensure continued system safety
- Particular attention will be required to ensure that:
OPERATIONAL USE OF RVSM

1) all aircraft operating in RVSM airspace are RVSM approved
2) the RVSM approval process remains effective
3) the TLS continues to be met
4) additional safety measures, introduced to reduce the risk as a result of operational errors
5) evidence of altimetry system error (ASE) stability exists
6) ATC procedures remain effective.
AIRCRAFT REQUIREMENTS AND APPROVAL

- RVSM HEIGHT-KEEPING PERFORMANCE
  - performance level that aircraft need to be capable of achieving in service (RVSM MASPS)

- AIRWORTHINESS APPROVAL
  - group or non-group

- CONTINUED AIRWORTHINESS
  - operator maintenance and inspection practices
AIRCRAFT REQUIREMENTS AND APPROVAL

STATE RVSM APPROVAL
Will encompass:

- Airworthiness approval (including continued Airworthiness)

- Operational approval
procedures that an operator may need to adopt for the airspace where RVSM is applied.
VALIDITY OF APPROVAL

- RVSM approval issued for one region will always be valid for RVSM operations in another region provided that specific operational approval is not required.

- The State of the Operator/State of Registry should formulate policies and courses of action with respect to aircraft/operators that are found to be operating in RVSM airspace without approval, which could jeopardize the safety of other users of the airspace.
The objective is to ensure that the operation of RVSM meets the safety objectives

the monitoring of aircraft technical height keeping performance aims to achieve the following:

a) confidence that the technical TLS of $2.5 \times 10^{-9}$ fatal accidents per aircraft flight hour will be met;

b) provide guidance on the efficacy of the RVSM MASPS and on the effectiveness of altimetry system modifications; and

c) provide evidence of ASE stability.
CRM parameters for monitoring

<table>
<thead>
<tr>
<th>First group</th>
<th>Second group</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) vertical overlap probability, $P_z$ (1 000)</td>
<td>c) aircraft relative speeds</td>
</tr>
<tr>
<td>b) airspace parameter (exposure to vertical collision risk):</td>
<td>d) aircraft dimensions</td>
</tr>
</tbody>
</table>

*For opposite and same direction:*

1. passing frequency  
2. lateral overlap probability, $P_y(0)$.  

*For crossing and direct routings:*

“Frequency of passing events involving horizontal overlap”
The frequency of occurrence of these errors is not considered to be a function of the separation minima applied.

The monitoring process will involve the collection of operational data, and appropriate methodologies to process this data to enable comparison with the agreed overall safety objectives.

The data may come from different sources.
ASSESSMENT AND EVALUATION OF OPERATIONAL ERRORS

- People reviewing and acting on these data should be prepared to take action as necessary.

- In the case of an unacceptable risk increase, a thorough assessment of the cause of the risk increase must be done, with increased monitoring vigilance to ascertain that the follow-up actions have the required risk-compensation and/or risk-reducing effect.
RESPONSIBILITIES

The evaluation of system performance encompass specific tasks of the various bodies which form a typical regional organization:

a) regional planning group;

b) regional monitoring agency; and

c) air traffic control.
RESPONSIBILITIES

Responsibilities of the regional planning group (RPG)

- Has the overall responsibility for deciding that RVSM should be implemented and continued.
Responsibilities of a regional monitoring agency (RMA)

- Has the overall responsibility for monitoring the different data associated with RVSM operations and report to the RPG.
RESPONSIBILITIES

- **Role of the appropriate ATC authority**

  - To gather information on and report any deviation equal to or greater than 90 m (300 ft), for any reason, from cleared levels whether the deviation causes an incident or not.

  - This information will contribute to the assessment of the level of overall risk in the system by the RMA.
CHALLENGES
First implementation of the RVSM was 1997; ICAO promulgated 2000-ft standard in 1958

So.....Why did it take so long to make the change?

Answer: Developing sufficient, reliable information on aircraft height-keeping performance is a challenging task

Aircraft height-keeping performance is the result of the performance of two aircraft systems: altitude-keeping system and altimetry system
Altitude-keeping system

Feedback control system designed to keep pressure altitude flown by aircraft at a commanded value.

Performance of system can be observed by both flight crew (altimeter reading) and air traffic control (secondary surveillance radar Mode C).

Common practice in RVSM work to refer to error in altitude keeping system as Assigned Altitude Deviation (AAD), similar to flight technical error.
Aircraft Height-Keeping Systems

- Altimetry system

- Barometric pressure sensor/transducer which translates ambient static pressure measured at an orifice on aircraft to geopotential feet (pressure altitude) by means of ICAO Standard Atmosphere

- Performance of system cannot be observed by either flight crew or air traffic control

- Error in this system referred to as altimetry system error (ASE)
Technical Challenge: Obtaining Empirical Evidence Concerning Aircraft Height-Keeping Performance

- Empirical evidence of height-keeping performance informs requirements-development process
  - Must know limits on feasible height-keeping performance in order to develop meaningful standards

- Empirical evidence of height-keeping performance permits assessment of individual-aircraft compliance with requirements
  - Assessment process is termed “monitoring height-keeping performance”

- Empirical evidence of height-keeping performance supports overall assessment of airspace system with RVSM safety goals
Technical Challenge: Obtaining Empirical Evidence Concerning Aircraft Height-Keeping Performance

- Aircraft assigned to fly a constant pressure altitude are attempting to adhere to an isobaric surface

- A constant-pressure surface, but not a constant-geometric-height surface

- Obtaining empirical evidence concerning height-keeping performance requires estimation of geometric height of aircraft and estimation of geometric height of isobaric surface defining the constant pressure altitude to which the aircraft is assigned by air traffic control
Technical Challenge: Obtaining Empirical Evidence Concerning Aircraft Height-Keeping Performance

- Overall error in adhering to flight level is termed “total vertical error” (TVE)

- Because of the statistically independent and additive nature of the two height-keeping system error sources:
  
  \[ TVE = ASE + AAD \]

  or

  \[ ASE = TVE - AAD \]

- Figure illustrating difficulties of obtaining empirical evidence of aircraft height-keeping performance for aircraft assigned to 35,000-ft pressure altitude (FL350)
Development of the RVSM - The Major Problem

FL 350 = Constant Pressure Altitude

FL 350 Geometric Height
Height Keeping Performance Errors

Aircraft geometric height

FL 350 Geometric Height

Total Vertical Error (TVE) = Altimetry System Error + Assigned Altitude Deviation
= ASE + FTE(AAD)
Develop process to estimate TVE, ASE and AAD to support RVSM

Need to estimate:

- Geometric height of aircraft
- Geometric height of flight level
- AAD
Example Of Estimation of Height-Keeping Performance

- Varig Flight 8923 – VRG8923
- Boeing 737-800
- Monitored in flight over Brazil while in revenue service
Geometric Height of Level Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.dfa
Date of Flight: 6/28/05
Aircraft Ident: Netwo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0

Unsmoothed DGPS Height (ft) * 10^3

Time (seconds) * 10^3
Geometric Height of Level Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.d
Date of Flight : 6/28/05
Aircraft Ident : Netwo
Flight Level   : 390
Start Time    : 63360.0
Stop Time     : 65280.0
Geometric Height of Flight Level

Flight Level Height (ft) * 10^3

Time (seconds) * 10^3

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.dfa
Date of Flight: 6/28/05
Aircraft Ident: Netwo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0
Location of Level Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.d
Date of Flight: 6/28/05
Aircraft Ident: N2tmo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0
Mode C Altitude During Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.dfa
Date of Flight: 6/28/05
Aircraft Ident: Netwo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0
Aircraft Performance During Level Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.dfa
Date of Flight: 6/28/05
Aircraft Ident: Netwo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0
Aircraft Performance During Level Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333m00.dfa
Date of Flight: 6/28/05
Aircraft Ident: Netwo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0
Aircraft Performance During Level Flight Segment

Processing Date: 07/08/05
DGPS input file: c:\050628\10333n00.dfa
Date of Flight: 6/28/05
Aircraft Ident: Netwo
Flight Level: 390
Start Time: 63360.0
Stop Time: 65280.0
AAD is constant. No cross-correlation between TVE' and AAD computed.

<table>
<thead>
<tr>
<th>variable</th>
<th>mean</th>
<th>s.d.</th>
<th>median</th>
<th>minimum</th>
<th>maximum</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft DGPS Height (WGS-84)</td>
<td>41018.04</td>
<td>35.80</td>
<td>41019.72</td>
<td>40939.22</td>
<td>41076.61</td>
<td>137.39</td>
</tr>
<tr>
<td>Aircraft Smooth DGPS Height (WGS-84)</td>
<td>41018.04</td>
<td>35.67</td>
<td>41019.93</td>
<td>40943.23</td>
<td>41073.92</td>
<td>130.69</td>
</tr>
<tr>
<td>VDOP of DGPS Height (WGS-84)</td>
<td>1.21</td>
<td>0.13</td>
<td>1.10</td>
<td>1.10</td>
<td>1.40</td>
<td>0.30</td>
</tr>
<tr>
<td>Flight Level Geopotential Height (MSL)</td>
<td>40854.60</td>
<td>35.17</td>
<td>40856.36</td>
<td>40791.62</td>
<td>40911.00</td>
<td>119.38</td>
</tr>
<tr>
<td>Root-Mean-Square FL - Bracknell Grid (MSL)</td>
<td>0.46</td>
<td>0.13</td>
<td>1.10</td>
<td>1.10</td>
<td>1.40</td>
<td>0.30</td>
</tr>
<tr>
<td>Aircraft (WGS-84) - FL Geopotential (MSL)</td>
<td>163.43</td>
<td>4.25</td>
<td>163.20</td>
<td>150.74</td>
<td>175.41</td>
<td>24.67</td>
</tr>
<tr>
<td>FL (geopotential - geometric) Height (MSL)</td>
<td>-168.11</td>
<td>2.64</td>
<td>-168.16</td>
<td>-172.56</td>
<td>-163.45</td>
<td>9.12</td>
</tr>
<tr>
<td>Flight Level Geometric Height (MSL)</td>
<td>41022.72</td>
<td>37.81</td>
<td>41024.52</td>
<td>40955.07</td>
<td>41083.56</td>
<td>128.50</td>
</tr>
<tr>
<td>Aircraft (WGS-84) - FL geometric (MSL)</td>
<td>-4.68</td>
<td>4.88</td>
<td>-5.87</td>
<td>-15.34</td>
<td>10.38</td>
<td>25.72</td>
</tr>
<tr>
<td>Flight Level Geometric Height (WGS-84)</td>
<td>40996.80</td>
<td>35.54</td>
<td>40997.33</td>
<td>40935.40</td>
<td>41056.65</td>
<td>121.25</td>
</tr>
<tr>
<td>TVE = (Aircraft-FL) Geometric Height (WGS-84)</td>
<td>21.24</td>
<td>4.37</td>
<td>20.58</td>
<td>7.07</td>
<td>33.44</td>
<td>26.37</td>
</tr>
<tr>
<td>AAD = Mode C - Flight Level * 100</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>AAD = Smooth Mode C - Flight Level * 100</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>ASE = (TVE - AAD)</td>
<td>21.27</td>
<td>4.36</td>
<td>20.60</td>
<td>7.10</td>
<td>33.40</td>
<td>26.30</td>
</tr>
</tbody>
</table>

Number of TVE observations: 1921
Number of ASE observations: 1910
Number of AAD observations: 268
RVSM IN THE WORLD
TECHNICAL REVIEW OF RVSM

Thank you!

SAULO SILVA
sdasilva@icao.int
The Global ATM System

Setting the Scene

Saulo Silva
ATM Section
Air Navigation Bureau, ICAO HQ

April 2010
Presentation Outline

- What is a Global ATM system?
- How do we get there?
- Planning structure
- Expectations
  - NextGen SESAR
  - ICAO
  - States
- Conclusions
What is Global ATM?
Physical connectedness
What is global ATM?
Meeting expectations

- Meeting the expectations of the aviation community
  - meeting safety objectives
  - operate along preferred 4D trajectories (business trajectories)
  - scheduling
  - gate availability
  - environmental objectives
  - other business requirements
What is global ATM?
Meeting expectations (cont’d)

- Major impediments
  - the existing ATM system
  - thousands of aircraft operators each have their own best outcomes
  - best outcomes go beyond aircraft operators and extend outward to the larger ATM community as well
What is global ATM?
Integration and a common vision

Information rich environment

People

Systems

Concept components

- ATM Service Provider
- Management
- Communications
- Navigation
- Surveillance
- Aircraft operations
- Maintenance Engineering
- Airspace User
- Conflict Management
- Airspace organization and Management
- ATM service delivery management
- Demand capacity balancing
- Traffic synchronisation
What is global ATM?
Seamlessness-Interoperability

- A seamless, interoperable, worldwide system based on:
  - Seamless safety across all regions
    - For all users during all phases of flight
  - Physical connectedness
    - Homogeneous ATM areas and Major Traffic flows
  - Common requirements, Standards and procedures
    - Integration (TMAs, aerodromes)
    - Performance based equipment carriage requirements
  - Common aeronautical information exchange models
  - Meets environmental objectives
What is Global ATM?
A wider perspective

- To make even greater gains in efficiency far-reaching cooperation is necessary
- A global vision
- Wider planning perspectives
- Implementation of facilities and services over larger geographical areas
- A global framework for performance measurement
What is Global ATM?
An example of a wider planning perspective

- RVSM
  - ICAO’s role in supporting the realization of RVSM was and continues to be significant
  - safety-related work leading to the development of Standards, Procedures and guidance material
  - planning and safety assessments conducted by the regional planning groups
  - RVSM could not have been implemented globally without ICAO’s leadership
What is Global ATM?  
Working together

- Toward a common vision
  - global ATM Operational Concept

- Using a common planning framework
  - Global Air Navigation Plan, the regional air navigation plans and several other documents and tools
  - Global Aviation Safety Plan (GASP)

- Utilizing performance objectives
  - Targets, metrics, indicators

- Global interoperability and harmonization are key to making further improvements
Eleventh Air Navigation Conference
How we get there

- Endorsed the global ATM operational concept
- Requested ICAO to:
  - develop ATM system requirements
  - address interoperability and seamlessness
  - define requirements for global AIM
  - publish the operational concept
  - amend the Global Plan
  - develop a performance framework
Eleventh Air Navigation Conference
How we get there

- That States and PIRGs consider the Global Air Navigation Plan for CNS/ATM Systems as a catalyst for change, providing a global safety and interoperability framework while allowing regional or local adaptation to efficiently meet regional and local needs.
35th Session of the Assembly
Endorses the global framework

- Assembly Resolution A35-15
- Calls upon States, regional planning groups and the aviation industry to use the ICAO Global ATM Operational Concept as the common framework to guide planning and implementation of CNS/ATM systems and to focus all such development work on the operational concept
Global performance initiatives
How we get there

- Options for ATM improvements
- Relate to ATM objectives in older version of Global Plan
- Result in direct performance enhancements
- Meet performance objectives
- Based on Industry Roadmaps and current regional activities
- Bring near- and medium-term benefits to aircraft operators
- Regional planning groups establish work programmes
Global performance initiatives
How we get there

- Reduced vertical separation minima
- RNAV and RNP (Performance-based navigation)
- Dynamic and flexible ATS route management
- Functional integration of ground systems with airborne systems
- Aerodrome design and management
- Data link applications
Planning structure

Global Planning (ICAO)

Regional planning (ICAO)

Bottom-up]

National planning (States)

[Top-down]

1. Operation Concept
2. Global Plan
3. Regional Air Navigation Plans
4. ATM Implementation/Operational Evolution Plans
5. Investment Plans
6. National Architectures

Operational Concepts

Strategic Plans

Etc.

SARPS
The ICAO Process Framework

Vision

Strategy

Tactics

Action

The concepts to implement the safety and efficiency strategic objectives

Global Air Navigation Plan

Global Aviation Safety Plan

Global Performance Initiatives (GPI)

Global Safety Initiatives (GSI)

Global and regional work plans as part of the business plan for ICAO led activities
### Performance Framework Form

- **Performance objective:**
- **Regional performance objective:**
- **National performance objective:**
- **Benefits:**
- **Strategy:**
- **ATM operational concept components:**
- **Tasks:**
- **Timeframe:**
- **Responsibility:**
- **Status:**
- **Linkage to global plan initiatives (GPIs):**

#### Benefits

<table>
<thead>
<tr>
<th>Environment</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>• reductions in fuel consumption;</td>
<td>• ability of aircraft to conduct flight more closely to preferred trajectories;</td>
</tr>
<tr>
<td>• increase in airspace capacity;</td>
<td>• facilitate utilization of advanced technologies (e.g., FMS based arrivals) and ATC decision support tools (e.g., metering and sequencing), thereby increasing efficiency.</td>
</tr>
</tbody>
</table>

#### Strategy

- **Short term (2010)**
- **Medium term (2011 - 2015)**

#### ATM OC Components

<table>
<thead>
<tr>
<th>ATM OC Components</th>
<th>Tasks</th>
<th>Timeframe Start-End</th>
<th>Responsibility</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AOM</strong></td>
<td><strong>En-route airspace</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• analyze the en-route ATS route structure and implement all identifiable improvements;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• implement all remaining regional requirements (e.g. RNP 10 routes); and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• finalize implementation of WGS-84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• monitor implementation progress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• develop a strategy and work programme to design and implement a trunk route network, connecting major city pairs in the upper airspace and for transit to/from aerodromes, on the basis of PBN and, in particular, RNAV/5, taking into account interregional harmonization;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• monitor implementation progress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2005-2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>linkage to GPIs</strong></td>
<td><strong>GPI/5:</strong> performance-based navigation, <strong>GPI/7:</strong> dynamic and flexible ATS route management, <strong>GPI/8:</strong> collaborative airspace design and management, <strong>GPI/11:</strong> RNP and RNAV SIDs and STARs and <strong>GPI/12:</strong> FMS-based arrival procedures.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Transition Strategy

NEAR-TERM

Evolution – Phase 1
- Based on what we HAVE today
- Involves application of available procedures, processes and capabilities
- Identifies potential “gap” requirements that focus near term work program activities

MEDIUM-TERM

Evolution – Phase 2
- Based on what we KNOW today
- Involves application of emerging procedures, processes and capabilities
- Identifies “gap” requirements and drives future R&D

LONG-TERM

Evolution – Phase 3
- Based on CONCEPT expectations
- Involves application of new procedures, processes and capabilities
- Fills “gap” requirements and sustains continuous improvement R&D

The “Overlap Period” indicates that there is no set date by which the objectives of each transition should be met – other than within a time band of perhaps 2-3 years. It also recognizes that some States or Regions may not have a specific performance requirement that would need the application of changes identified in the transition maps at the same time as another State or Region.
Expectations

- NextGen (in their own words)
  - Many of the concepts build on ICAO’s Global ATM Operational Concept which represents a globally harmonized set of concepts for the future
  - We recommend that ICAO assess NextGen and other future systems to advance harmonization efforts and to ensure global collaboration in the development and acceleration of standards for required future systems
Expectations

- SESAR (in their own words)
  - Planning should be in accordance with the Global Plan
  - Planning should be based on specific performance objectives supported by Global Plan Initiatives
  - The terminology and methodology used in the Master Plan are consistent with ICAO
Expectations

- ICAO
- To harmonize all the regional/national initiatives to guarantee seamlessness.
Expectations

- States
- To guarantee that the best service is delivery at the correct time to the correct customer with high level of efficiency and attending the agreed levels of safety.
In Summary

- The goal is a more seamless Global ATM system
- We are getting closer
- Global ATM Operational Concept
- Global Air Navigation Plan
- We should work under one common umbrella
  - Performance based transition
  - Continued operational improvements
  - Toward a common vision
  - Using the ICAO framework
- Expectations
The Global ATM System

Thank you.

Saulo Silva

sdasilva@icao.int