Special Implementation Project

CNS/ATM Systems – Interoperability and Harmonization

(Presented by H.V.SUDARSHAN)

Workshop on the development of business case for the implementation of CNS/ATM systems

Cairo, 6–9 September  2004
ICAO-Vision Statement

To foster the implementation of 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
✓ meets national security requirements.
ICAO AIR NAVIGATION
PLANNING PROCESS

NAMPG
NATSPG
EANPG

REGIONAL PLANNING
NATIONAL PLANNING
INTER REGIONAL PLANNING
SUB-REGIONAL PLANNING

GREPECAS
APIRG
APANPIRG

“Interface” issues
Regional Harmonization

Region A

Initial Use of Components

Region B

Regional Harmonization
Why do we need Harmonization?…

• Current Air Navigation systems
  ✓ Country-specific
  ✓ Stand-alone (high diversity, different protocols)
  ✓ Lack similar functionalities
  ✓ No standard interfaces

• Thus resulting in
  ✓ Set of “island” solutions
  ✓ Incoherent ATC systems
Why do we need Harmonization?....

- CNS/ATM systems have
  - Number of operational options
    - RNP, Horizontal and vertical separation standards
  - Number of technical options
    - Data links, GNSS augmentation systems
  - Number of Organizational options
    - Different service providers (global, regional, subregional/multinational and national)

(2/3)
Why do we need Harmonization?

- CNS/ATM systems have
  - Different timings in implementation
  - Different levels of implementation
  - Different methods of financing and cost recovery
What is Harmonization?

- What is harmonization as applied to CNS/ATM systems planning and implementation?

  ✔ Accord or agreement for a consistent, orderly implementation and the use of CNS/ATM systems through global interoperability thus resulting in an integrated, seamless Global ATM system
What to Harmonize?

• Between current air navigation systems and CNS/ATM systems
  ✓ Operational procedures
  ✓ Technical systems
  ✓ Institutional format

• Amongst CNS/ATM systems
  ✓ Operational procedures
  ✓ Technical systems
  ✓ Institutional format
Harmonization of Air Navigation Systems

Methods

• Systems approach
  ✓ ATM
  ✓ Communications
  ✓ Navigation
  ✓ Surveillance

• Major traffic flow approach
  ✓ ATM objectives
  ✓ ATM requirements for communications, navigation and surveillance
Approach to Harmonization of Air Navigation Systems
A Framework

1. Define ANS partner
2. Determine harmonization area for ANS
3. List major traffic flows
4. Identify the air navigation infrastructure
   - New systems
   - Current systems
5. Identify interface issues
   - Amongst new systems
   - Between current and new systems
6. Resolve interface issues
7. Align timelines/apply harmonization tools
8. Take follow-up action to implement harmonized plan
9. Results in harmonized air navigation systems
Air Navigation Systems Partners

- States
  - ✓ ANS service providers
- Subregional groups
- Regional groups
- Airspace users
- International Service providers
- Manufacturers
Interface Areas for Air Navigation Systems

- Within the area
  - State
  - Subregion
  - Region

- Across the area
  - Inter-State
  - Inter-subregion
  - Inter-region
Homogeneous ATM Areas and Major Traffic Flows

Homogeneous ATM Area

An airspace with a common ATM interest based on similar characteristics of traffic density, complexity, air navigation infrastructure requirements or other specified considerations, wherein a common detailed plan fosters the implementation of interoperable CNS/ATM systems
Homogeneous ATM Areas and Major Traffic Flows

Major Traffic Flows

Major traffic flow: A concentration of significant volumes of air traffic on the same or proximate flight trajectories.

Note: Major traffic flows may cross several homogeneous ATM areas with different characteristics

Routing area: A defined area encompassing one or more major traffic flows
Selecting Homogeneous ATM Areas and Major Traffic Flows

• Identify major traffic flows
  ✓ Within the homogeneous ATM area under consideration such as
    ▪ State
    ▪ Subregion
    ▪ Region
  ✓ Across the homogeneous ATM area under consideration such as
    ▪ Inter-State
    ▪ Inter-subregion
    ▪ Inter-region
Air Navigation Systems
Infrastructure

• **Present**
  ✓ Take stock of the current inventory of technical systems and operational procedures

• **Future**
  ✓ Take into account what is being planned in terms of technical systems and operational procedures
Infrastructure – Current Systems

• Air traffic management
  ✓ ATS Route structure
  ✓ Separation standards
  ✓ Airspace reservation
  ✓ ATC procedures
  ✓ Flow management

• Communications/navigation/surveillance
  ✓ Data and voice communications
  ✓ En-route, approach and landing aids
  ✓ Primary and secondary radars
## Infrastructure – Future Systems

<table>
<thead>
<tr>
<th>Communication</th>
<th>Navigation</th>
<th>Surveillance</th>
<th>Air Traffic Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td><strong>GNSS</strong></td>
<td><strong>SSR</strong></td>
<td><strong>ASM</strong></td>
</tr>
<tr>
<td>- VHF</td>
<td>- GPS</td>
<td>- Modes A/C</td>
<td>- ATS Route structure</td>
</tr>
<tr>
<td>- HF</td>
<td>- GLONASS</td>
<td>- Mode S</td>
<td>- RNP and RNAV</td>
</tr>
<tr>
<td>- Mode S</td>
<td>- *GALILEO</td>
<td>- ADS</td>
<td>- Airspace utilization</td>
</tr>
<tr>
<td>- Satellite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ATN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Voice</strong></td>
<td><strong>Augmentation</strong></td>
<td><strong>ADS</strong></td>
<td><strong>ATS</strong></td>
</tr>
<tr>
<td>- VHF</td>
<td>- ABAS</td>
<td>- VHF</td>
<td>- ATC</td>
</tr>
<tr>
<td>- Satellite</td>
<td>- GBAS</td>
<td>- HF</td>
<td>- RHSM and RVSM</td>
</tr>
<tr>
<td></td>
<td>- SBAS</td>
<td>- Satellite</td>
<td>- Search and Rescue</td>
</tr>
<tr>
<td></td>
<td>- *GRAS</td>
<td></td>
<td>- Decision support</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>ATFM</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Coordination</td>
</tr>
</tbody>
</table>

*emerging systems*
Interface Issues

• Between current air navigation systems and CNS/ATM systems
  ✓ Operational procedures
  ✓ Technical systems
  ✓ Institutional format

• Amongst CNS/ATM systems
  ✓ Operational procedures
  ✓ Technical systems
  ✓ Institutional format
Interface Issues – Between Current Air Navigation Systems and CNS/ATM Systems

✓ Operational procedures
  ▪ Reserved and flexible use of airspace
  ▪ Non RNP and RNP environment
  ▪ Non RVSM and RVSM environment

✓ Technical systems
  ▪ ACARS and VDL air/ground data communications
  ▪ Analog and digital voice communications
  ▪ Ground-based and satellite-based navigation aids
  ▪ Different geodetic reference systems
  ▪ Radar and ADS
Interface Issues – amongst CNS/ATM Systems

Communications/Navigation/Surveillance

- Different air/ground data links (HFDL, AMSS, SSR Mode S and VDL Modes 2, 3 & 4)
- Different GNSS augmentation systems (SBAS, GBAS and *GRAS)
- Different satellite constellations (GPS, GLONASS and *Galileo)
- Different surveillance systems (primary radars, secondary radars, ADS-A and *ADS-B)

» * Emerging systems
Interface Issues – amongst CNS/ATM Systems

Air Traffic Management

✓ Operational procedures
  ▪ Different RNP environments
  ▪ Different Regional airspace safety performance monitoring structure
  ▪ Different operational approvals for RNP
  ▪ ???
## Resolution of Interface Issues

### Mechanism

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MECHANISM</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>States</td>
</tr>
<tr>
<td>Subregional</td>
<td>Subregional Groups</td>
</tr>
<tr>
<td>Regional</td>
<td>Planning &amp; Implementation Regional Groups</td>
</tr>
<tr>
<td>Interregional / Global</td>
<td>Interregional interface meetings and ALLPIRG</td>
</tr>
</tbody>
</table>
Application of Interface Tools

Between Current Air Navigation Systems and CNS/ATM Systems

✓ Align implementation timelines
✓ Apply harmonization tools
  ▪ VHF data analog/digital: Message processor/dual stack
  ▪ VHF voice analog/digital: Multi-mode radio
  ▪ ILS/MLS/GNSS: Multi-mode receiver
  ▪ PSR/SSR Mode S/ ADS: Integrated ATC work station
  ▪ ATC procedures to respond to different requirements
Application of Interface Tools

Amongst CNS/ATM Systems

- Align implementation timelines
- Apply harmonization tools
  - VHF data/AMSS/HF/SSR Mode S: ATN
  - GPS/GLONASS/*GALILEO: integrated GNSS receiver
  - WAAS/EGNOS/MSAS: Interoperability SARP
  - SBAS/GBAS: integrated GNSS receiver
  - SSR Mode S/ ADS-A/*ADS-B: Integrated ATC work station
- ATC Procedures to respond different requirements
  * Emerging systems
Follow-up Tasks

- Decide on the new timeframe as a consequence of aligning the implementation timelines
- Plan for implementing the appropriate harmonization tools
- Incorporate the relevant changes in the regional air navigation plan (ANP)
- Present the revised regional ANP to the respective PIRG meeting for its concurrence
Harmonization of Air Navigation Systems

**Benefits**

- Interoperability
- Standardization
- Seamlessness
- Cost-effectiveness
- Easy migration path
- Enhanced safety

Resulting in an integrated global air traffic management system
### Interregional issues for Regional Harmonization being addressed

<table>
<thead>
<tr>
<th>Issue</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional guidance material on the RNP operational approvals process for each RNP types is required</td>
<td>Guidance on the RNP 10/RNP 4 approval process has been provided. Development of guidance material for RNP 1 approval is in progress</td>
</tr>
<tr>
<td>Provisions and guidance material for annotation of RNP requirements on aeronautical charts</td>
<td>Development completed and released by ICAO as an amendment to chart manual</td>
</tr>
</tbody>
</table>

(1/6)
### Interregional issues for Regional Harmonization being addressed

<table>
<thead>
<tr>
<th>Issue</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined GNSS receiver to integrate signals from different constellations</td>
<td>SARPs for combined GPS/GLONASS receiver have been developed; Issues associated with combined use of GPS and Galileo are under consideration by the GNSS Panel of ICAO</td>
</tr>
<tr>
<td>Harmonization of different satellite-based augmentation systems for GNSS (WAAS/EGNOS/MSAS)</td>
<td>SARPs for SBAS have been developed; SBAS interface issues are being addressed by GNSSP of ICAO and the Interoperability Working Group, which is comprised of SBAS service providers.</td>
</tr>
</tbody>
</table>
## Interregional issues for Regional Harmonization being addressed

<table>
<thead>
<tr>
<th>Issue</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of an operational concept of air traffic management</td>
<td>Draft ATM operational concept as developed by ATMC Panel was approved by ICAO</td>
</tr>
</tbody>
</table>
| Development of an uniform standard for use by States in certification of aircraft for RVSM operation | SASP of ICAO has developed a new chapter
  “Aircraft requirements and approvals”, and included in the Second edition of RVSM Manual (Doc 9564) |
Interregional issues for Regional Harmonization being addressed

<table>
<thead>
<tr>
<th>Issue</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS route planning and implementation between regions</td>
<td>Being addressed as part of the work programme of interregional coordination meetings by ICAO Regional offices and PIRGs</td>
</tr>
<tr>
<td>Harmonization of procedures for transition from RVSM levels to non-RVSM levels</td>
<td></td>
</tr>
<tr>
<td>Issue</td>
<td>Current Status</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Progressive implementation of ATN islands, domains and backbones and their interconnections</td>
<td>Guidance material has been developed; To be addressed in due course by the interregional coordination meetings by ICAO Regional offices and PIRGs</td>
</tr>
<tr>
<td>Multi-mode receiver (MMR) for integrating ILS/MLS/GNSS</td>
<td>MMR specifications have been finalized; The equipage is presently under development by the Industry</td>
</tr>
</tbody>
</table>
### Interregional issues for Regional Harmonization being addressed

<table>
<thead>
<tr>
<th>Issue</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of ANP/FASID documents of all the regions</td>
<td>This is presently under finalization; The documents already made available excepting for MID and Asia/Pacific regions</td>
</tr>
<tr>
<td>Application of BORPC for all the regions</td>
<td>This is presently under consideration by the Commission and expected to be approved by January 2005</td>
</tr>
</tbody>
</table>
Examples of Harmonization in implementation of Air navigation systems

Interregional approach

• Revision of interregional ATS Trunk Route Structure covering Europe/ Middle East/Asia
  ▪ Task is coordinated amongst three regions
  ▪ Implementation date aligned to 28 Nov 2002
• Implementation of RVSM on interregional Major Traffic Flow from Asia to Europe through Middle East
  ▪ Task is coordinated amongst three regions
  ▪ Implementation date aligned to 27 Nov 2003

(1/4)
Examples of Harmonization in implementation of Air navigation systems

Interregional approach

• Implementation of RVSM on interregional Major Traffic Flow from South America to Europe through Africa
  ▪ Task was coordinated amongst three regions
  ▪ Already implemented from 24 Jan 2002
• Implementation of RVSM on interregional Major Traffic Flow from South America through Caribbean to North America
  ▪ Task is coordinated amongst three regions
  ▪ Implementation date aligned to 20 Jan 2005
Examples of Harmonization in implementation of Air navigation systems

Regional approach

• Implementation of RNP5/RNAV in Middle East region on selected routes
  ▪ Task was coordinated amongst States of the region
  ▪ Already implemented from 14 June 2001
• Implementation of AMHS in Asia/Pacific region
  ▪ Task is coordinated amongst States of the region
  ▪ Implementation date aligned to 2005
Examples of Harmonization in implementation of Air navigation systems

Subregional approach

• Implementation of Ground/Ground communications network in SADC/ Central Caribbean subregion.
  ▪ Task was coordinated amongst the States of subregion using subregional approach
  ▪ Already implemented

• Implementation of RNP5/RNAV in ECAC area
  ▪ Task was coordinated amongst the States of subregion using subregional approach
  ▪ Already implemented in January 1998