



NPF/SIP/2010-WP/7

# **Global Air Navigation System ~Elements~**

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**International Civil Aviation Organization**

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**Workshop on development of  
National Performance Framework for  
Air Navigation Systems  
(Nairobi, 6-10 December 2010)**

# Presentation outline

- **Strategic vision of ATM community**
- **Area of responsibility**
- **Phases of flight**
- **Global ATM system**
- **Air Navigation system infrastructure – ATM, CNS, AIM, AGA and MET**

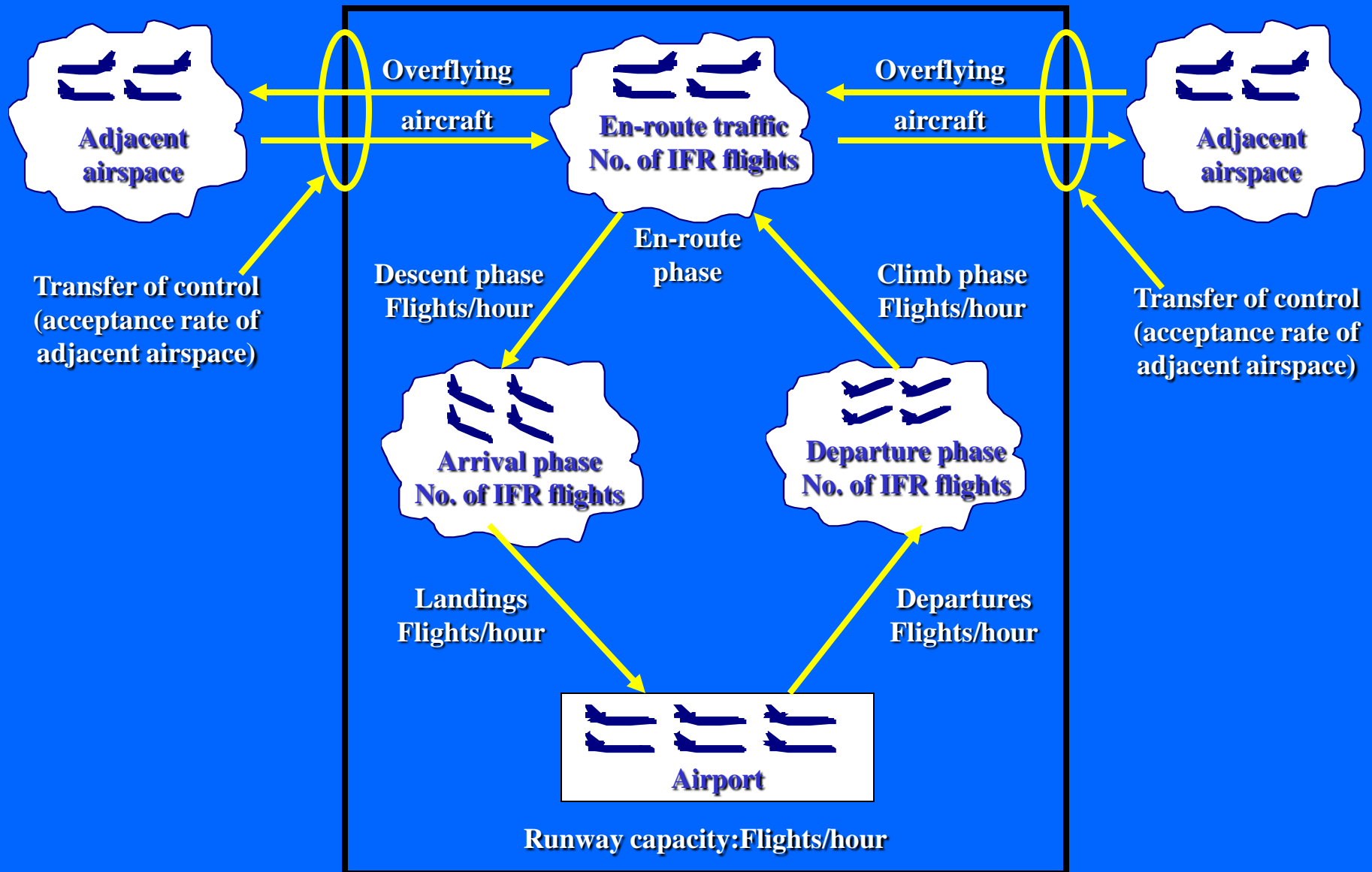
# **ATM Community**

## **~ Strategic vision ~**

**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**

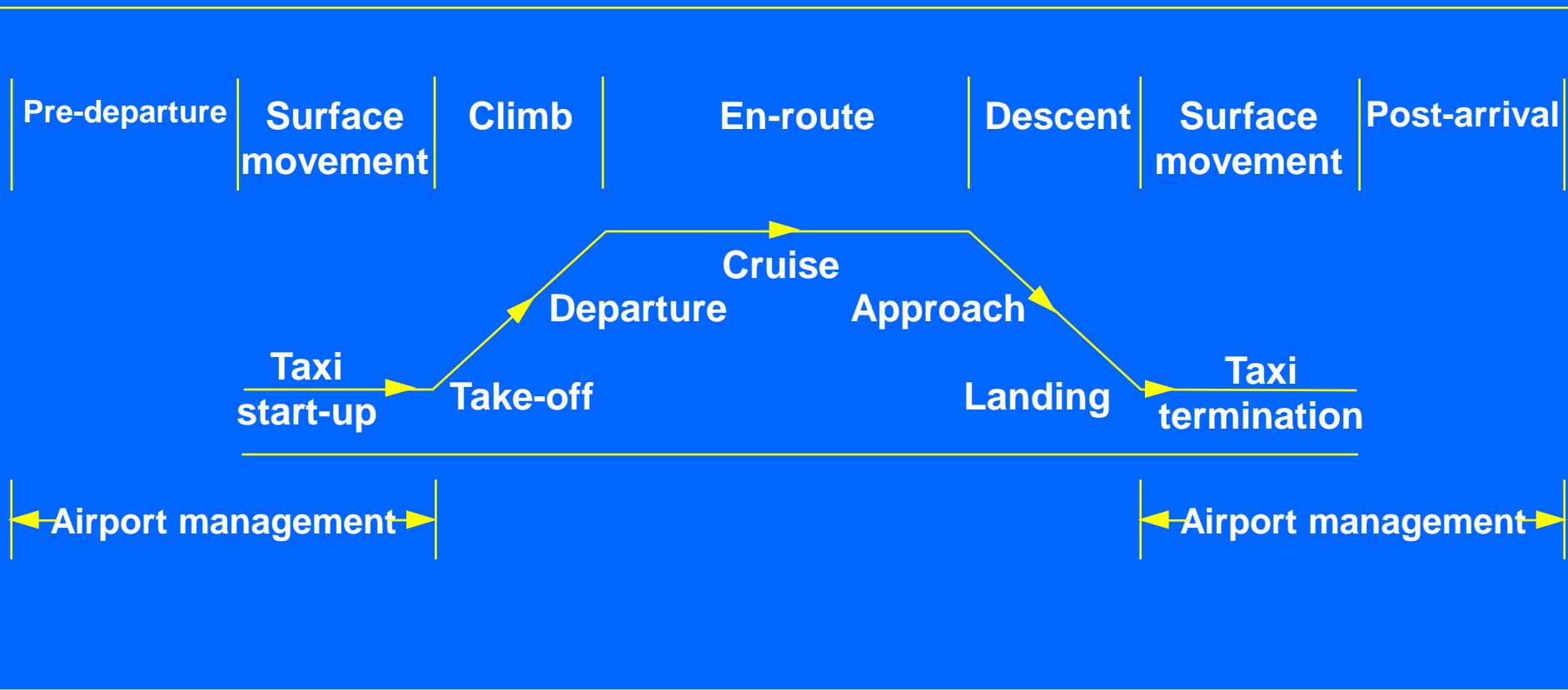
# AREA OF RESPONSIBILITY OF A STATE



## Capacity assessment for ATM

# Phases of flight

## Gate to Gate Operation



# **What is Global ATM system?**

**Global ATM system can be understood as a worldwide system which:**

- facilitates interoperability of different technologies,**
- accommodates different procedures, and**
- provides harmonization leading to seamlessness across regions**

**This is achieved through progressive, cost effective and cooperative implementation of air navigation systems worldwide .**

# **Global ATM system - Architecture**

**Air Navigation system architecture to Support  
ATM Operational Concept:**

- **ATM**
- **AIM**
- **AGA**
- **MET**
- **CNS**

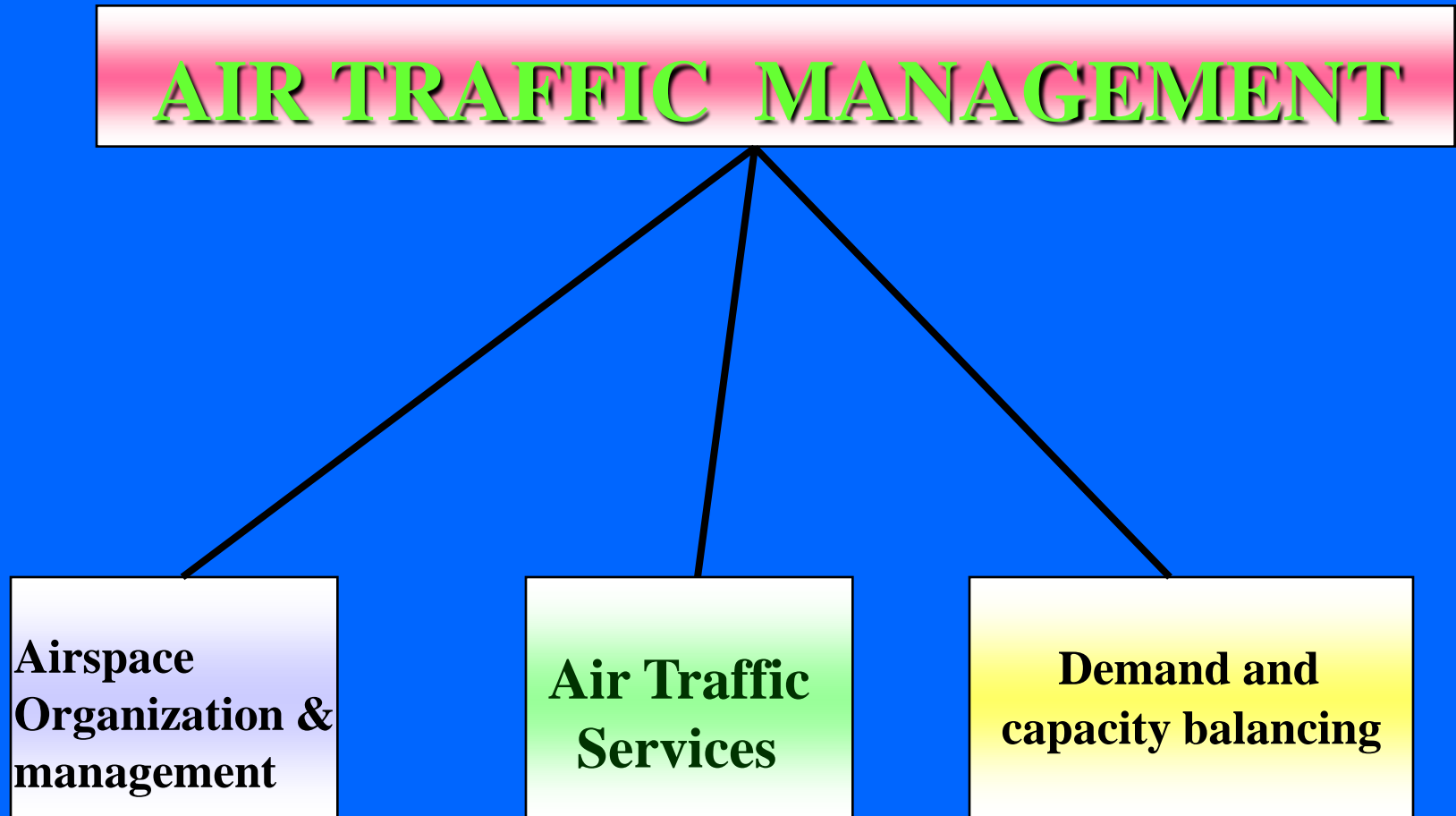
# **Air Traffic Management**

# **Air Traffic Management**

## **~ Definition (March 2007)~**

**Air traffic management is the dynamic, integrated management of air traffic and airspace (including ASM,ATS and ATFM)—safely, economically, and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground based functions**

# ATM - Elements



# Airspace organization and management

- **Airspace organization**
  - **ATS route structure**
    - **fixed routes**
    - **PBN routes**
- **Airspace management**
  - **fixed and flexible use of airspace**
  - **civil/military coordination**
  - **optimized sectorization**

# Air traffic services ...

## ➤ Conflict management

- flight information
- area control
- approach control
- aerodrome control
- surface movement control

## ➤ Search and Rescue

- Emergency locator transmitter (ELT) of COSPAS and SARSAT(406 MHz from 1 Feb 2009) and no satellite coverage for 121.5 MHz

# Air traffic services ...

- **Decision support systems**
  - **conformance monitoring; MTCA/STCA; MSAW**
  - **PRM for independent IFR approaches to closely spaced runways**
  - **arrival metering and sequencing system**
  - **AIDC**
- **Separation standards**
  - **Reduced Horizontal Separation Minimum (RHSM) and Reduced Vertical Separation Minimum (RVSM)**

# Air traffic services

## ➤ Applications

- data link
- use of curved and segmented approaches
- A-SMGCS

# Demand and Capacity balancing ...

## ➤ Objective

- to ensure an optimum flow of air traffic through areas during times when demand exceeds or is expected to exceed the available ATC capacity
- Traffic synchronization

## ➤ Application of tools

- re-routing; and
- allocation of slots

# DCB

## ~ Phases of activity ~

- **Strategic phase:** Strategic activities are research, planning and coordination activities carried out in the period from two days to several months in advance of the day of operation
- **Pre-tactical phase:** Pre-tactical activities are planning and coordination activities carried out within the two days prior to the day of operation
- **Tactical phase:** Tactical flow activities that are carried out on the day of operation
- **Airborne flights:** Action on individual flights before their departure and shall not normally intervene in the progress of airborne flights which are the responsibility of the appropriate ATC unit. However, airborne flights may be subject to additional tactical flow measures

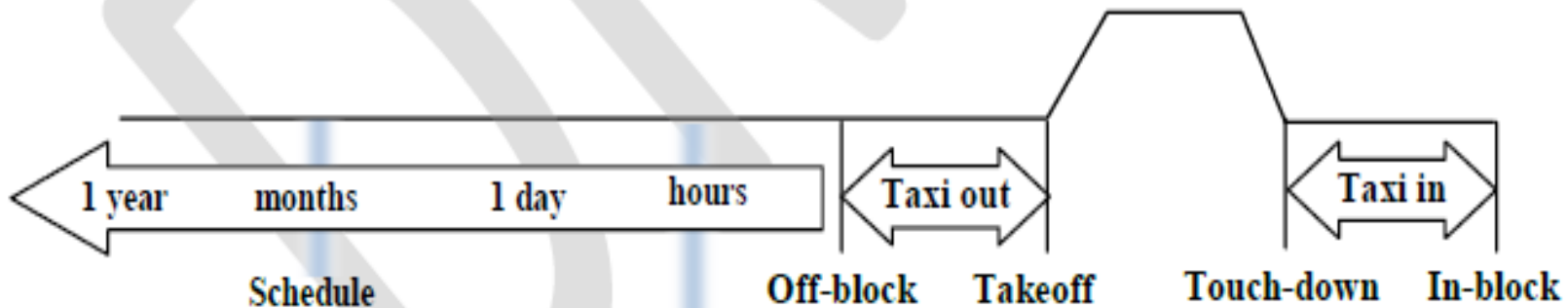
# DCB

Scheduling & Strategic  
Activities § 3.4.1

Pre-Tactical Operational  
Planning § 3.4.2

Tactical Operational Planning  
§ 3.4.3

Flight Operations § 3.4.4



Weather,  
Winds, Special Use Airspace,  
Airframes known

# ATM - Summary

AOM	ATS	DCB
<ul style="list-style-type: none"> <li>•ATS Route structure</li> <li>•PBN (RNP and RNAV)</li> <li>•Airspace utilization</li> <li>•FUA</li> <li>•Airspace Safety</li> </ul> <p>Monitoring</p>	<ul style="list-style-type: none"> <li>•Air Traffic Control</li> <li>•RHSM and RVSM</li> <li>•Search and Rescue</li> <li>•Decision support systems</li> <li>•ATS Safety Programmes</li> </ul>	<ul style="list-style-type: none"> <li>•Planning</li> <li>•Coordination</li> <li>•ATS capacity</li> <li>•Collaborative Decision Making</li> </ul>

# **Communications/Navigation/ Surveillance**

# **CNS elements in PBN**

## **✈ CNS Elements in a Performance Based Air Navigation System**

- ✓ Based on Performance Standards rather than specific technologies or equipment**
- ✓ Recognizes the ability of modern aircraft to operate safely and efficiently using an integration of on-board systems and external signals**

# CNS Architecture

## → Today

✓ Many CNS Technologies

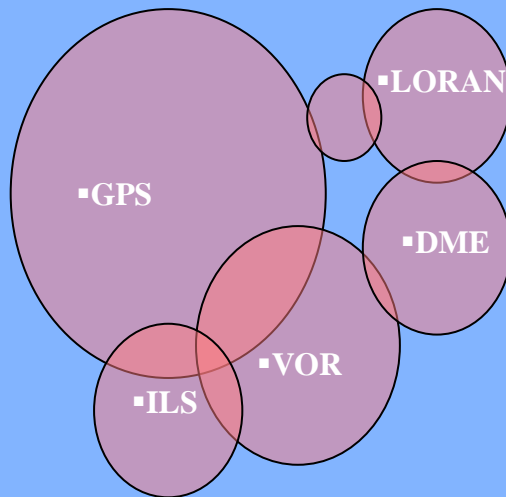
✓ Many standards

✓ Regional solutions

✓ Regional service variations

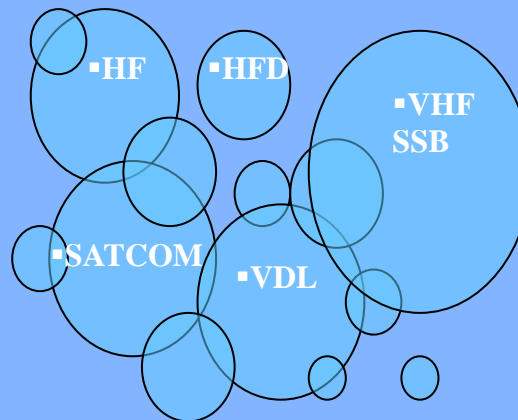
▪ Existing Navigation

▪ Systems



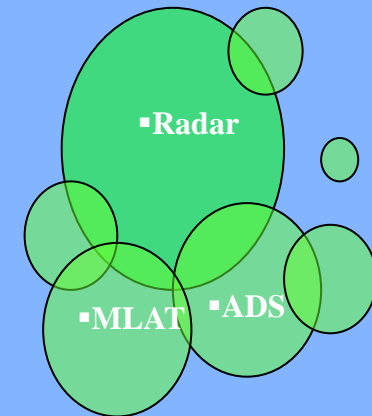
▪ Existing Communications

▪ Systems



▪ Existing Surveillance

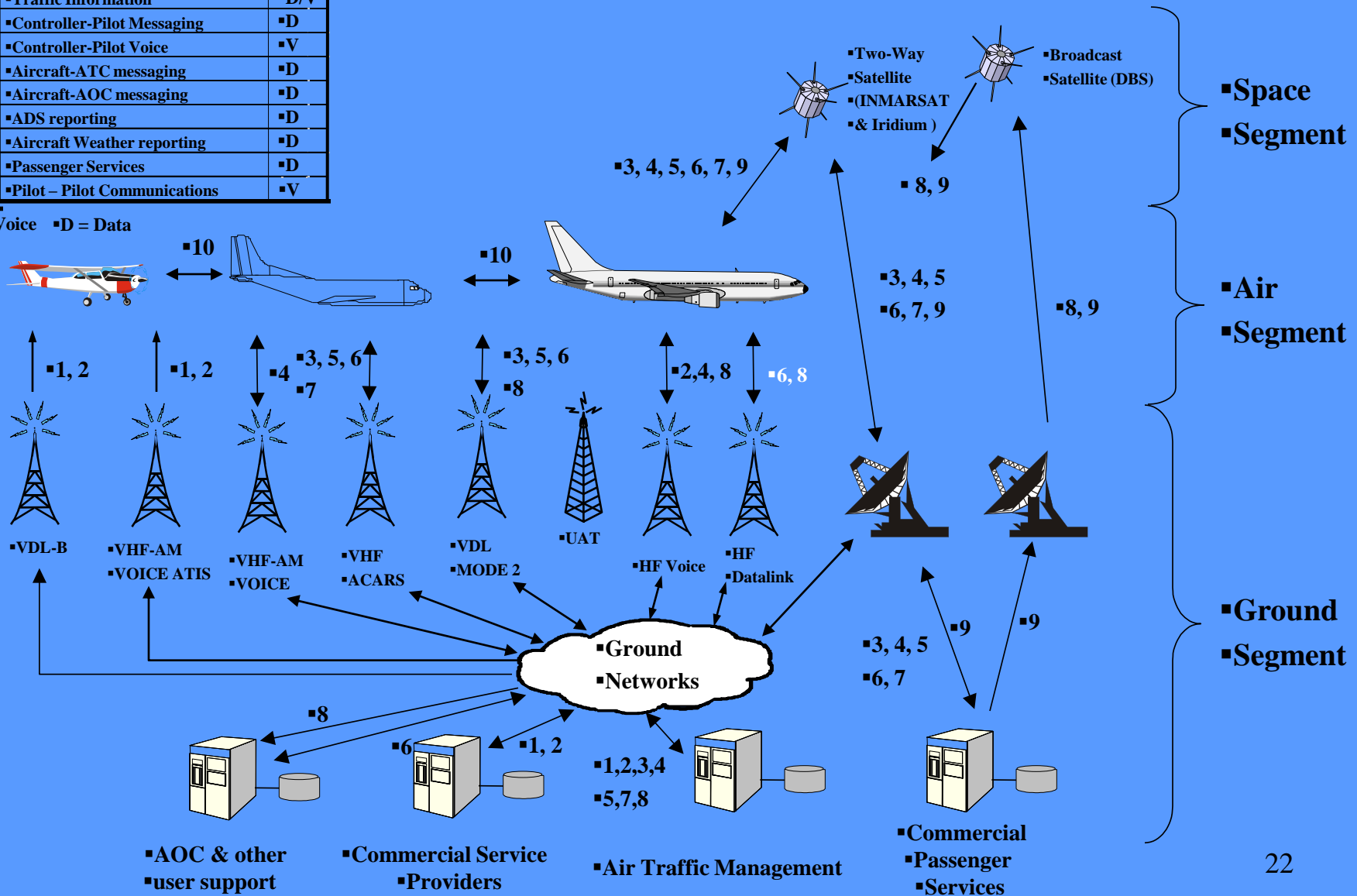
▪ Systems



# Communication Architecture

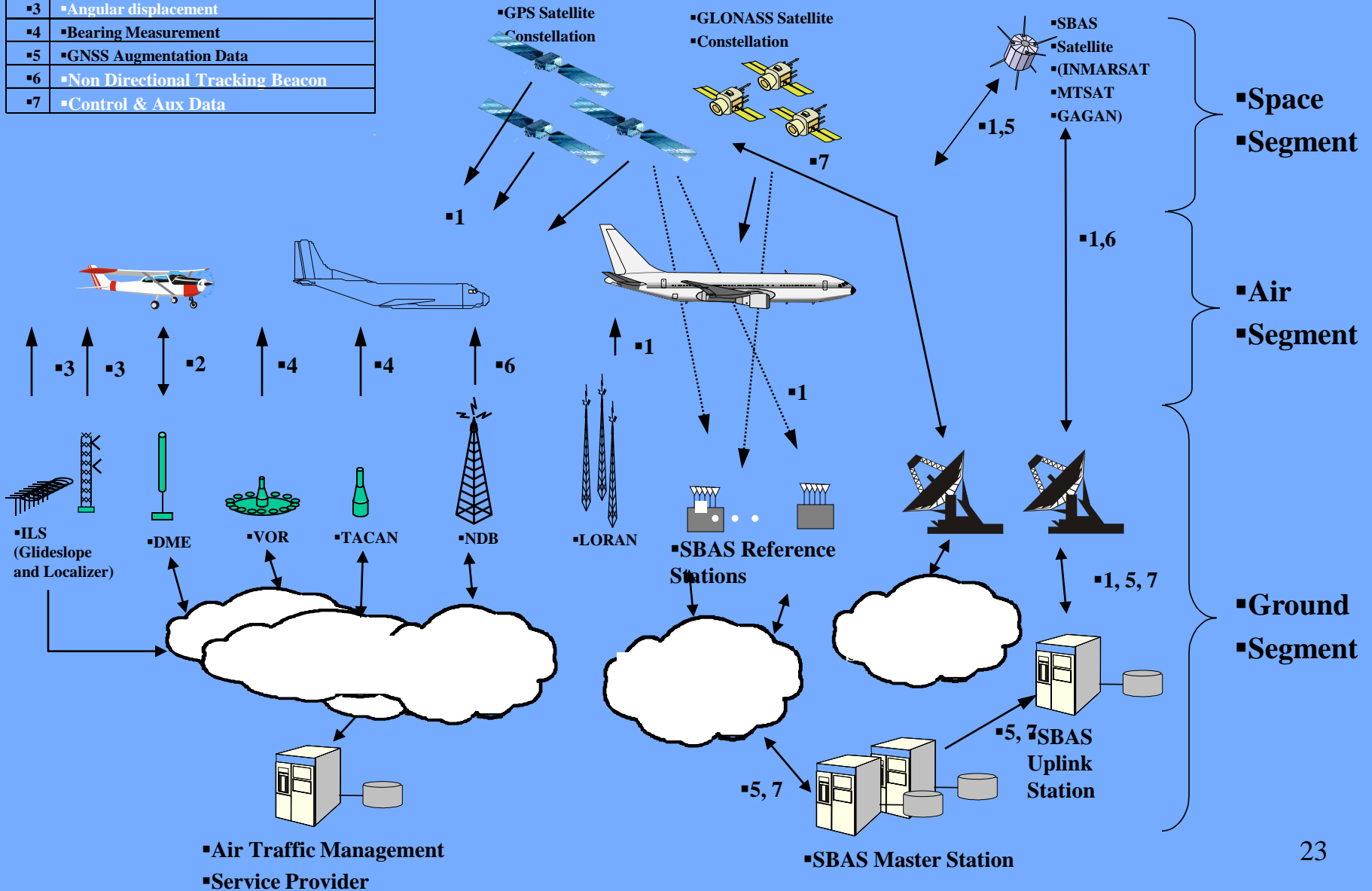
Communication Types		
1	Flight Information	D/V
2	Traffic Information	D/V
3	Controller-Pilot Messaging	D
4	Controller-Pilot Voice	V
5	Aircraft-ATC messaging	D
6	Aircraft-AOC messaging	D
7	ADS reporting	D
8	Aircraft Weather reporting	D
9	Passenger Services	D
10	Pilot - Pilot Communications	V

V = Voice D = Data



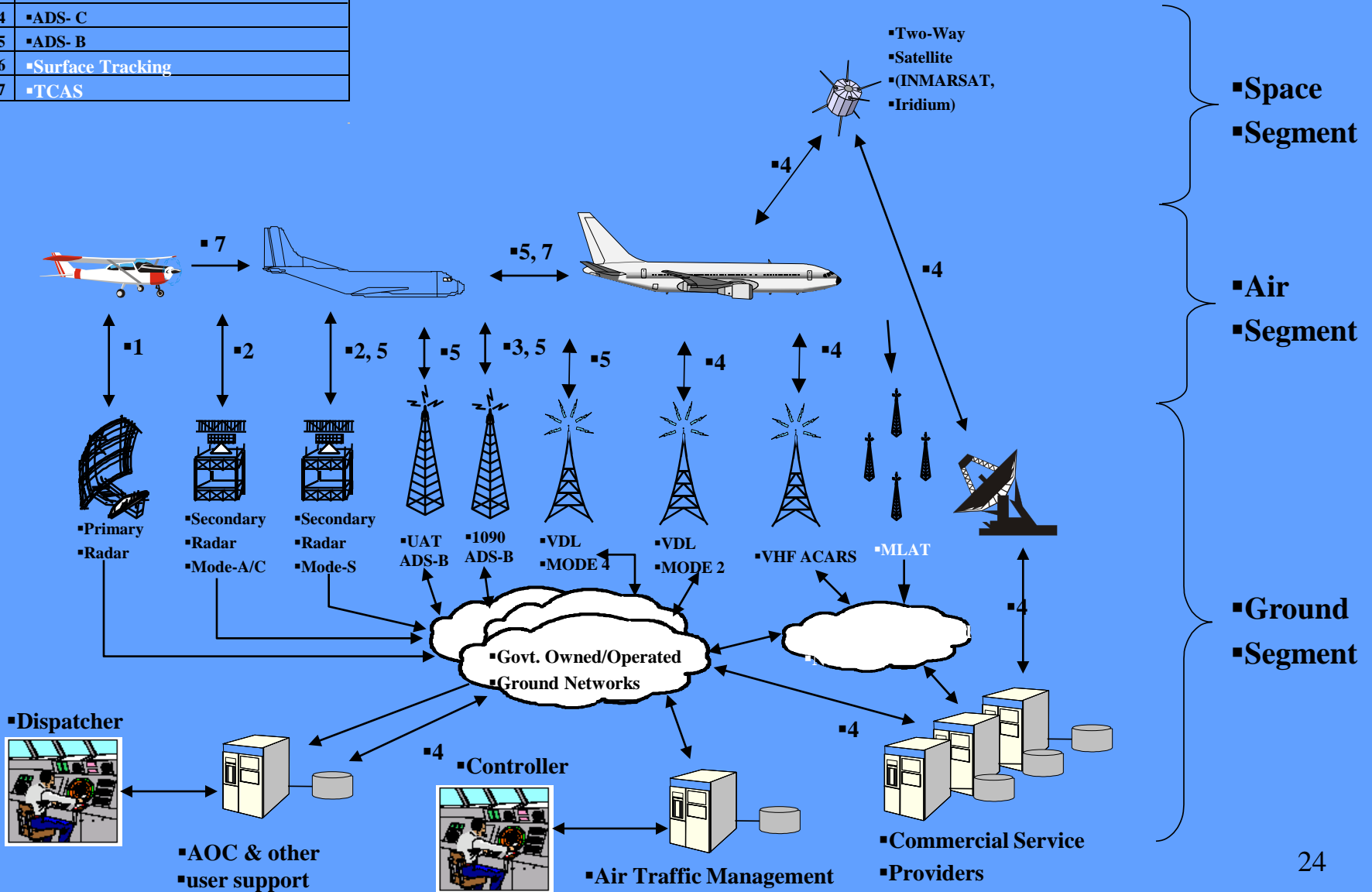
# Navigation Architecture

Navigation Types	
1	Range Signal Broadcast
2	Two way pulse ranging
3	Angular displacement
4	Bearing Measurement
5	GNSS Augmentation Data
6	Non Directional Tracking Beacon
7	Control & Aux Data



# Surveillance Architecture

Surveillance Types	
1	Non-Cooperative Radar
2	Cooperative Radar
3	Multilateration
4	ADS- C
5	ADS- B
6	Surface Tracking
7	TCAS



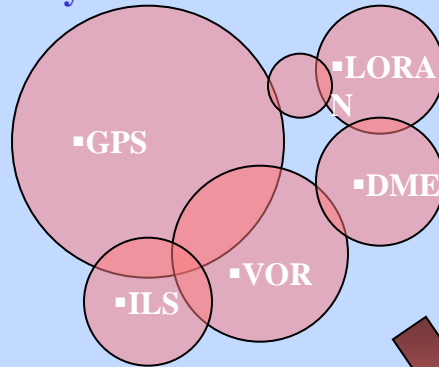
# CNS Elements Transition

## Today

- Plethora of Disjoint CNS Technologies
- Regional solutions
- Many standards
- Regional service variations

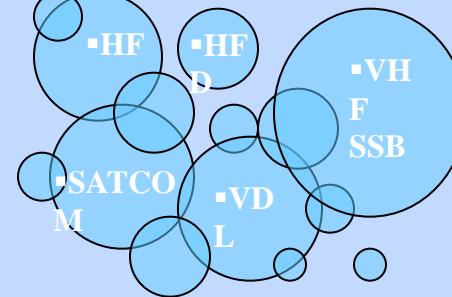
### Existing Navigation Systems

#### Systems



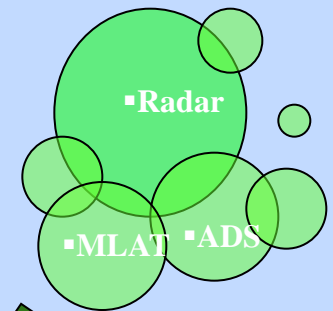
### Existing Communications Systems

#### Systems



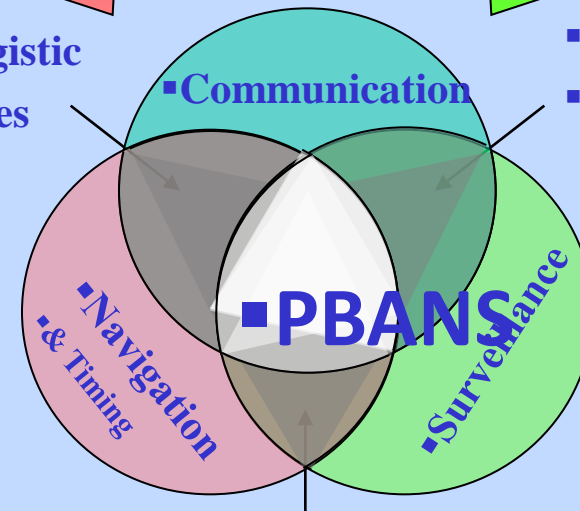
### Existing Surveillance Systems

#### Systems



- Synergistic Services

- Inherent Redundancy



- Lower Total Cost to Provide Services

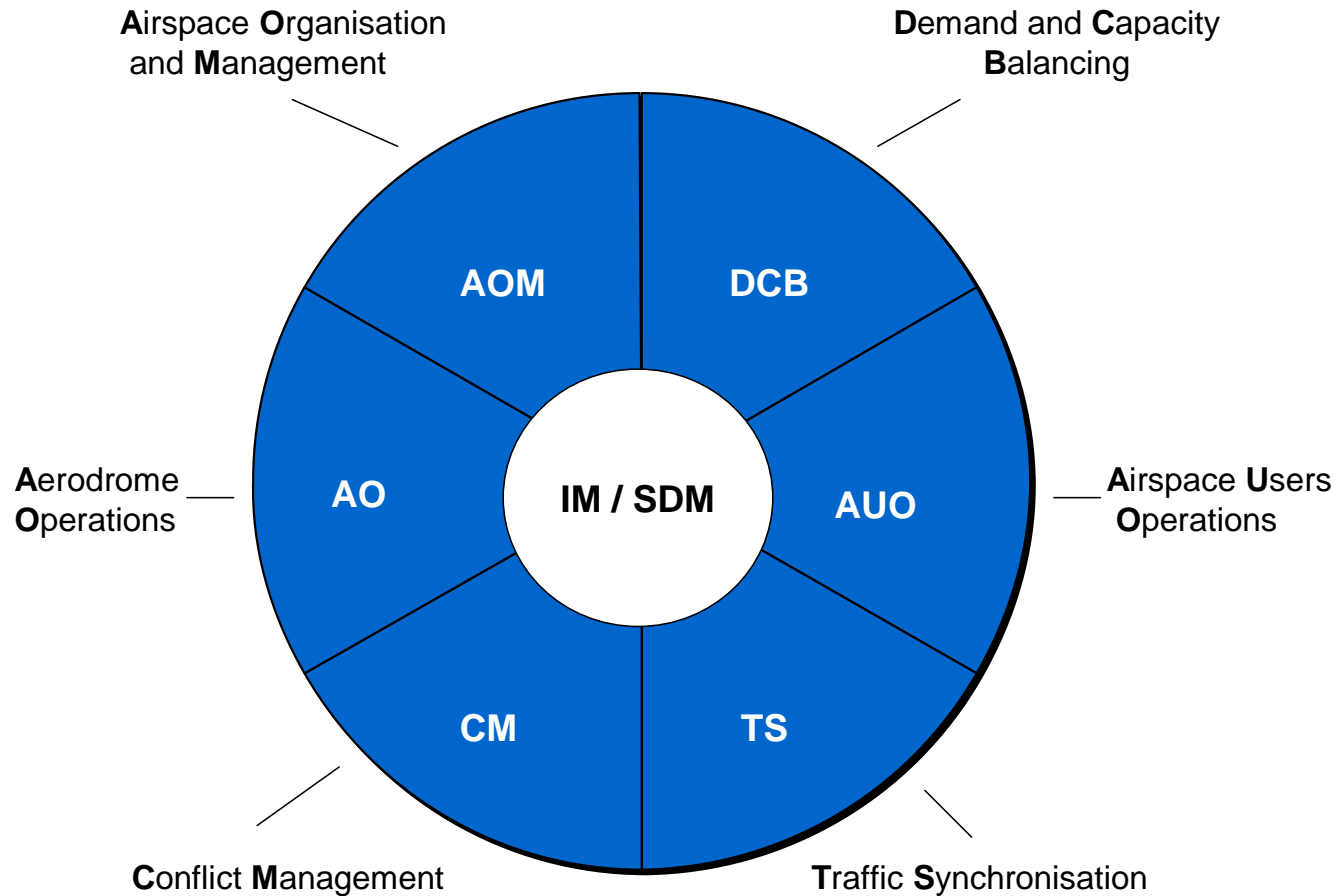
- Performance Based Air Navigation System
- Integrated CNS
- Global utility
- Global standard
- Uniform levels of service

# Summary: CNS elements

Communication	Navigation	Surveillance
<b>Data</b> <ul style="list-style-type: none"> <li>• VHF</li> <li>• HF</li> <li>• Mode S</li> <li>• Satellite</li> <li>• ATN</li> <li>• UAT</li> </ul>	<b>GNSS</b> <ul style="list-style-type: none"> <li>• GPS</li> <li>• GLONASS</li> <li>• *GALILEO</li> </ul>	<b>PSR</b>
	<b>Augmentation</b> <ul style="list-style-type: none"> <li>• ABAS</li> <li>• GBAS</li> <li>• SBAS</li> </ul>	<b>SSR</b> <ul style="list-style-type: none"> <li>• Modes A/C</li> <li>• Mode S</li> </ul>
<b>Voice</b> <ul style="list-style-type: none"> <li>• VHF</li> <li>• Satellite</li> <li>• HF VOIP</li> </ul>	<b>DME/DME</b>	<b>ADS-C</b> <ul style="list-style-type: none"> <li>• VHF</li> <li>• HF</li> <li>• Satellite</li> </ul>
		<b>ADS-B</b>
		<b>MLAT</b>

# **Aeronautical Information Management**

# IM Central component of ATM System



**IM / SDM = Information Management / ATM Service Delivery Management**

# **Aeronautical Information Management**

## **~ Definition (Dec. 2008)~**

**Aeronautical Information Management is the dynamic, integrated management of aeronautical information services — safely, economically, and efficiently — through the provision and exchange of quality assured digital aeronautical data in collaboration with all parties.**

# AIM - Elements

- **Phase 1 : Consolidation**, mainly quality requirements; AIRAC adherence; WGS-84; and the provision of terrain and obstacle data.
- **Phase 2 : Going digital**, introduction of database-driven processes (eAIP, AIXM); enhance the quality and availability of existing products.
- **Phase 3 : Information Management**, new products and services; provision of the new data that will be required by the future ATM components.

# Transition to AIM

- **2009 - Completed. AIS-AIMSG** first meeting 2-4 Dec. 2008, see <http://www.icao.int/anb/aim>, -
  - **Amendment 36 Annex 15** effective from July 2010.  
**Amendment 56 Annex 4; ( e-AIP, AIXM Recommendations, public internet, QMS)**
  - **Amendment 2 Doc 8126** (update to AIS Manual);
  - **Amendment 30 PANS-ABC** (an update)
- **2010, Going digital**
  - **Start developing Amendment 37 Annex 15** ( update to AXIM, eAIP, eTOD& Amendment 57 Annex 4 (electronic charting, instrument procedure charts);
  - **Recommendations and guidance on data exchange, no obligations.**
  - **Standards for eAIP, AIXM, Training, Quality Guidance Material**

# Transition to AIM

## ➤ 2013, Information Management

- Amendment 37 Annex 15 & Amendment 57 Annex 4 become applicable.
- Possible **Divisional Meeting** in 2014 to agree on new requirements for data exchange.

## ➤ 2016, Transition achieved

- Amendment 38 to Annex 15 (Standards for AIXM and restructuring ) & Amendment 58 to Annex 4 (restructuring ) would become applicable including recommendations of divisional meeting to be held in 2014

# AIM -Summary

- **WGS-84 (standard since 1998)**
- **e-TOD (now standard for area 1 and 4 and recommendations for area 2 and 3)**
- **e-AIP (Recommendation now in PDF)**
- **Digital data exchange (Recommendation now and number of States are using it)**
- **Digital NOTAMS (phase 3 of road map -2016)**
- **Quality management systems (Standard since 2000)**

# **Aerodrome Operations**

# **AGA -Elements**

- **aerodrome certification**
- **new visual aids for prevention of runway incursions**
- **visual aids for denoting wind turbines**
- **advanced VDGS to improve apron safety**
- **enhanced rescue and fire fight provisions**
- **wildlife strike hazard reduction**
- **heliports**

# Aerodrome Certification

▪As of 27 Nov 2003,  
States shall certify  
aerodromes used for  
international  
operations in  
accordance with the  
specifications  
contained in Annex 14,  
Vol I,



# **Future Works (by 2012)**

- **New runway safety provisions on:**
  - **runway end safety area (RESA)**
  - **visual aids to prevent runway incursions**
  - **surface friction measurement and reporting**
- **Enhanced provision on Aerodrome Emergency Plan (AEP) and Rescue and fire fighting (RFF)**
- **New efficiency provisions on use of light emitting diodes (LED) technology for visual aids**

# AGA –Summary

- **Aerodrome ground lighting**
- **Rapid exit taxiways**
- **Non navigation visual aids (PAPI)**
- **Rescue and fire fighting services**
- **Use of LEDs for prevention of Runway incursion**
- **Use of automated FOD detection system**
- **Aerodrome emergency planning including pandemic planning**
- **Availability of RESA**
- **Runway safety programme**

# **Meteorology**

# **MET in support of safety and efficiency - methods**

- **enhanced accuracy & timeliness of OPMET info**
  - **Where: en-route, in terminal area & at aerodromes**
  - **When: during flight planning & in-flight**
- **consolidation of certain services to a limited number of regional/global MET centres**

# **MET in support of safety and efficiency – impact**

- **Optimization of flight trajectory**
  - **Avoiding hazardous weather and volcanic ash**
  - **Preventing unnecessary closure of airspace (min. safe re-routing of aircraft)**
  - **Minimizing the environmental impact**
- **Optimum use of available airport capacity**
- **Increased cost effectiveness**

# **MET elements (1/2)**

- **WAFS: world area forecast system**
  - **2 world area forecast centres**
- **IAVW: international airways volcano watch**
  - **9 volcanic ash advisory centres**
- **ITCW: international tropical cyclone watch**
  - **7 tropical cyclone advisory centres**

**Above elements in line with CNS/ATM features**

- 1. Global coverage**
- 2. Seamless**
- 3. Using digital technologies**
- 4. mix of satellite and ground-based systems**

# MET elements (2/2)

- **MET Watch**
  - **Some 200 MET watch offices**
- **Aerodrome MET service  
(including terminal area)**
  - **100's of meteorological offices  
(MET Offices)**

# Changes in 2010 (1/2)

## ➤ **WAFS**

- **Gridded forecasts for CB, icing & turbulence (will eventually replace SIGWX forecasts)**
- **Enhanced temporal & spatial resolutions**

## ➤ **IAVW**

- **Enhancements to accuracy & timeliness of info related to volcanic ash**

# Changes in 2010 (2/2)

- **Air-reporting**
  - **Elimination of voice routine reports (in view of ~ 200000 automated daily reports)**
- **QMS (in support of SMS)**
  - **Mandatory concerning all MET elements**
- **Aerodrome MET service**
  - **Fully automated local MET reports**

# IVATF

- **International Volcanic Ash Task Force (IVATF) was established in June 2010 in response to the recent Icelandic volcanic eruption.**
- **It is a coordinating body involving ATM, OPS (airworthiness) and MET**
- **encourage research and development in view of determining what constitutes an acceptable level of volcanic ash in the atmosphere for aircraft operations.**

# Future developments (beyond 2010)

- **Aerodrome MET service**
  - **Migration from alpha-numerical codes to XML**
  - **Enhancement of MET support to ATM**
    - **To be based on evolving ATM requirements**
    - **Expected to evolve beyond aerodrome/terminal area**
- **MET watch**
  - **Consolidation of the issuance of SIGMET to regional centres corresponding to *functional airspace blocks***

# MET –Summary (1/2)

## ➤ TMA (Measuring the weather)

- Sensors for wind speed and direction; temperature, RVR/visibility, barometric pressure, precipitation and cloud height
- Record and broadcast to pilots through ATIS broadcast or data link

## ➤ TMA (Forecast the weather)

- Aerodrome forecast (TAF)
- Trend forecast (as per RAN agreement to cover the next 2 hours )
- Wind shear and aerodrome weather warning

# MET –Summary (2/2)

- **Enroute (Forecast the weather)** – useful tool for flight planning, choosing optimum routes and to avoid hazardous weather conditions
  - WAFS (World Area Forecasting System)
  - TCAC (Tropical Cyclone Advisory Centre)
  - VAAC (Volcanic Ash Advisory Centre)
  - SADIS/ISCS will distribute the above forecasts to all States
- **SIGMET: Ensure that SIGMET are issued to users for each airspace**

— END —