



## **Agenda Item 6c: Need for a CNS Technology Roadmap**

Prosper Zo'o Minto'o

Regional Officer, Communications, Navigation and Surveillance  
ICAO Eastern and Southern African Office

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Managers**

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## Introduction (1/2)

- APIRG/17 identified many urgent deficiencies that affect the CNS infrastructure in the region. A great number of these deficiencies concern ground-ground communications, despite the deployment and/or upgrading of dedicated satellite networks (such as AFISNET, CAFSAT, NAFISAT, SADC VSAT networks) applying modern technologies.
- These deficiencies which are due to lack of implementation of air navigation plan (ANP) requirements or lack of system compatibility limit effective provision of air traffic management (ATM) and have an adverse impact on air transport operations safety and efficiency.

## Introduction (2/3)

- Today, those responsible for the planning of CNS systems are confronted with a bewildering array of choices, and few understand the differences between these technologies, what utility they provide or when they may be required.
- For air navigation service providers (ANSPs) and aircraft operators, the implementation of new CNS technologies requires significant investment.
- For aircraft operators there is also the added expense of certification and downtime. Most important to both groups is the early return on investment.
- For this, the implementation programmes of ANSPs and aircraft operators must be in unison.

## Introduction (3/3)

- Lacking are clearly stated global requirements that have agreed operational benefits with defined timelines for implementation. This makes long-term investment agreements and decisions difficult for States. These decisions are critical as advanced capabilities like 4D-trajectory and System-Wide Information Management (SWIM) will depend on advanced CNS technologies.
- This presentation points out areas where certainty is lacking and proposes the development of a global CNS technology roadmap to provide the needed certainty for States and all aviation stakeholders.

# Examples of Uncertainties (1/4)

## Technologies

- In the late 1980s, ICAO initiated the development of the Aeronautical Telecommunications Network (ATN) using the available technology at the time, known as open systems interconnect (OSI). Although some elements of ATN were implemented, it was never globally deployed or offered in its final form by aircraft manufacturers.
- In the mid-1990s IP became the global standard. ICAO recognized this and Amendment 83 to Annex 10 was adopted, offering two technical options for the ATN: one using OSI and the other using IP.
- Today OSI-based communications systems are becoming obsolete.

## Examples of Uncertainties (2/4)

### ATS message handling system (AMHS)

- AMHS connectivity is being implemented by some States using OSI, while others are using IP. Complex gateways are available which convert between OSI and IP. The proposed roadmap would show how and when such solutions should be employed.

### Air-ground communications

- ICAO Standards exist for both OSI and the IP versions of VHF air-ground data link communications. Today only OSI is used and avionics manufacturers have no plans to develop IP-based equipment in the near future.
- States are encouraged to implement the ATN using IP wherever possible for ground-ground communications but not, as explained above, for air-ground communications.

## Examples of Uncertainties (3/4)

- More complex gateways will be the interim solution to link the mixed protocols of an IP-based ground infrastructure to an OSI-based air/ground infrastructure.
- Airport surface communications data link systems based on IPs are planned for 2014. Additionally, future satellite systems for aeronautical telecommunications will be IP-based. VHF data link, on the other hand, has no choice but to continue to be based on OSI until late in this decade. This system will be used in parallel with various IP-based communications links.
- **How States and regions will manage this and how long this situation will last** is unknown at this time.
- **A transition roadmap is needed** to address these questions.

# Examples of Uncertainties (4/4)

## Terminology

- Air-ground data link can be supported by various systems, i.e:
  - FANS-1/A; FANS-1+/A+; FANS-2/B; ATN/OSI, ATN/IPS, etc. These are not interoperable systems.
- Some systems may share protocols but have different functions.
- Others may have the same function but use different communications protocols.
- Airlines and aircraft manufacturers require clear guidance and business plans on how to equip international fleets.
- Clarity is needed for international aviation planning. This too, is a goal of the proposed roadmap.

# Need for a CNS Technology Roadmap (1/3)

- Numerous CNS “roadmaps” have been produced, however, these tend to have a limited focus and lack international agreement, for example, airframe manufacturers have developed avionics-focussed roadmaps; and the US FAA and EUROCONTROL have developed roadmaps for their specific programmes (NextGen, SESAR).
- At the same time, the ICAO Global Plan initiatives (GPIs) pertaining to CNS and their associated strategies need to be implemented consistently by all stakeholders, at global and regional level.
- A global roadmap applicable to international aviation as a whole, that informs all States of the prospective capabilities of aircraft and also the implementation programmes of progressive ATS providers is missing.

## Need for a CNS Technology Roadmap (2/3)

- Benefits of this roadmap would include:
  - predictable implementation with early achievement of operational benefits and returns on investment; and
  - widespread deployment, which will ease transition issues.
- Lengthy transition periods increase costs for aircraft operators and ANSPs given that dual systems must be supported either in the air or on the ground. Idle equipment in the air or on the ground generates costs with no forthcoming benefits.
- An interactive means of presenting information that is applicable to all stakeholders, States or regions is needed. ICAO has the capability to produce such an online, interactive, graphics-based, information tool.

## Need for a CNS Technology Roadmap (3/3)

- Such an interactive roadmap should address:
  - who it applies to - an ANSP, aircraft operator, airframe manufacturer;
  - where it applies – which State, region or flight information region;
  - what equipment and capability is required;
  - when the equipment and capability is required;
  - why the equipment and capability is required – operational benefits or a mandate; and
  - operational constraints and conditions to ensure that the benefits are achieved.
- Such a roadmap should become the global source of information for CNS technology implementation decisions for all stakeholders.
- ICAO is the lead organization to produce and maintain such a roadmap
  - The endorsement of the 37<sup>th</sup> ICAO Assembly was essential for this effort.

# Developing The Roadmap

- The development of a CNS roadmap will require the cooperation of all stakeholders. To engage the stakeholders (including industry groups, airframe and avionics manufacturers), they will be consulted and their cooperation requested.
- Simple correspondence will be routinely used to update the roadmap however a means to obtain comprehensive updates will also be needed.
- A ready solution exists: many CNS panels and working groups now enjoy regular participation by industry stakeholders.
- Updates to the CNS technology roadmap will be made a standing agenda item for these meetings.



## Global Air Navigation Plan Initiatives (1/2)

- The *Global Air Navigation Plan*, was developed on the basis of an industry roadmap in an effort to facilitate implementation of the Recommendations of the 11<sup>TH</sup> Air Navigation Conference and ensure that focused efforts would lead to near- and medium-term benefits.
- The Global Plan, therefore, contains near- and medium-term guidance on air navigation system improvements necessary to support a uniform transition to the ATM system envisioned in the operational concept.
- In accordance with the Global Plan, planning will be focused on specific performance objectives, supported by a set of “Global Plan Initiatives” (“initiatives”).



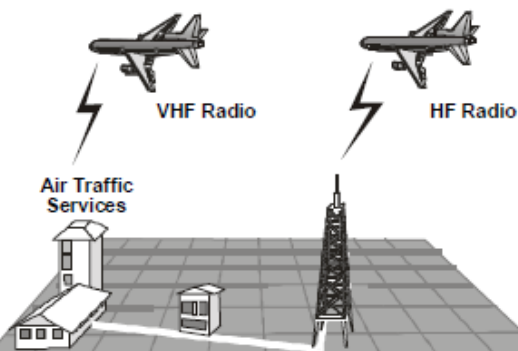
## Global Air Navigation Plan Initiatives (2/2)

- Global Plan Initiatives (GPIs) are options for air navigation system improvements that when implemented result in direct performance enhancements.
- States and regions will choose initiatives that meet performance objectives, identified through an analytical process, specific to the particular needs of a State, region, homogeneous ATM area or major traffic flow.

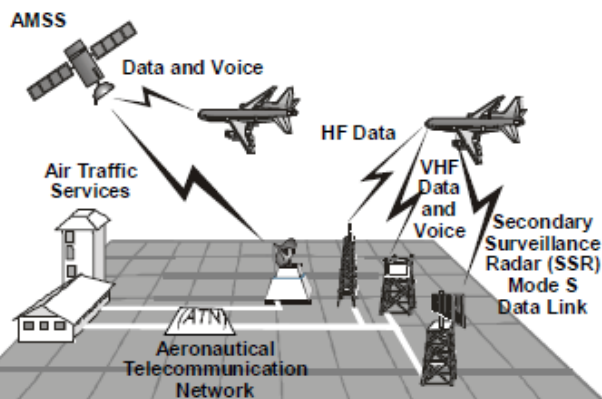
# Communications Infrastructure (GPI-22)

## Communications

Communications: Current Environment



Communications: Future Environment





## Communications Infrastructure (GPI-22) (1/2)

- ATM depends extensively and increasingly on the availability of real-time or near real-time, relevant, accurate, accredited and quality-assured information to make informed decisions.
- The timely availability of appropriate aeronautical mobile and fixed communication capabilities (voice and data) to accommodate ATM requirements and to provide the adequate capacity and quality of service requirements is essential.
- The aeronautical communication network infrastructure should accommodate the growing need for information collection and exchange within a transparent network in which all stakeholders can participate.

## Communications Infrastructure (GPI-22) (2/2)

- The gradual introduction of performance-based SARPs and system-level and functional requirements will allow the increased use of commercially available voice and data telecommunication technologies and services.
- In the framework of this strategy, States should, to the maximum extent possible, take advantage of appropriate technologies, services and products offered by the telecommunication industry.
- Considering the fundamental role of communications in enabling aviation, the common objective is to seek the most efficient communication network service providing the desired services with the required performance and interoperability required for aviation safety levels at minimum cost.

## Data link applications (GPI-17) (1/3)

- The implementation of less complex data link services (e.g. pre-departure clearance, oceanic clearance, D-ATIS, automatic position reporting) can bring immediate efficiency benefits to the provision of ATS. Transition to the use of data link communications for more complex safety-related uses that take advantage of a wide variety of CPDLC messages, including ATC clearances, is already being successfully implemented.
- Use of CPDLC and implementation of other data link applications can bring significant advantages over voice communication for both pilots and controllers in terms of workload and safety.

## Data link applications (GPI-17) (2/3)

- In particular, they can provide efficient linkages between ground and airborne systems, improved handling and transfer of data, reduced channel congestion, reduced communication errors, interoperable communication media and reduced workload. The reduction of workload per flight translates into capacity increases and enhanced safety.
- Communication data link and data link surveillance technologies and applications should be selected and harmonized for seamless and interoperable global operations. ADS-C, ADS-B and CPDLC are in service in various regions of the world but lack global harmonization. Current regional initiatives, including utilizing unique message subsets and CPDLC procedures, hinder efficient development and acceptance for global aircraft operations.

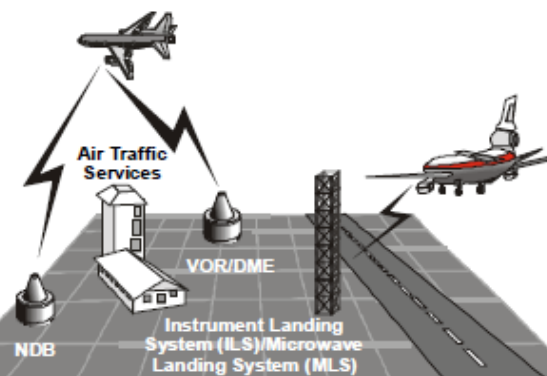
## Data link applications (GPI-17) (3/3)

- Existing and emerging technologies should be implemented in a harmonized global manner in the near term to support long-term goals. Harmonization will define global equipage requirements and therefore minimize user investment.
- FANS-1/A and aeronautical telecommunication network (ATN) applications support similar functionality, but with different avionics requirements.
- Many internationally-operated aircraft are equipped with FANS-1/A avionics initially to take advantage of data link services offered in certain oceanic and remote regions.
- FANS-1/A equipage on international business aviation aircraft is underway and is expected to increase.

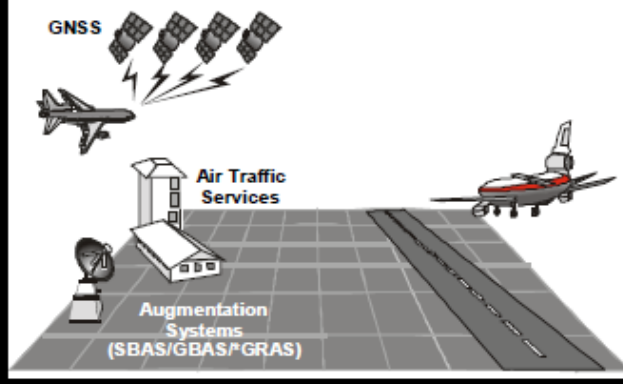
# Navigation Systems (GPI-21)

## Navigation

Navigation: Current Environment



Navigation: Future Environment



## Navigation Systems (GPI-21) (1/3)

- Airspace users need a globally interoperable navigational infrastructure that delivers benefits in safety, efficiency and capacity. Aircraft navigation should be straightforward and conducted to the highest level of accuracy supported by the infrastructure.
- To meet those needs, the progressive introduction of performance-based navigation must be supported by an appropriate navigation infrastructure consisting of an appropriate combination of global navigation satellite systems (GNSS), self-contained navigation systems (inertial navigation system) and conventional ground-based navigation aids.
- GNSS provides standardized positioning information to the aircraft systems to support precise navigation globally.

## Navigation Systems (GPI-21) (2/3)

- One global navigation system will help support a standardization of procedures and cockpit displays coupled with a minimum set of avionics, maintenance and training requirements.
- Thus, the ultimate goal is a transition to GNSS that would eliminate the requirement for ground-based aids, although the vulnerability of GNSS to interference may require the retention of some ground aids in specific areas.
- GNSS-centered performance-based navigation enables a seamless, harmonized and cost-effective navigational service from departure to final approach that will provide benefits in safety, efficiency and capacity.

## Navigation Systems (GPI-21) (3/3)

- GNSS implementation will be carried out in an evolutionary manner, allowing gradual system improvements to be introduced. Near-term applications of GNSS are intended to enable the early introduction of satellite-based area navigation without any infrastructure investment, using the core satellite constellations and integrated multisensory airborne systems. The use of these systems already allows for increased reliability of non-precision approach operations at some airports.
- Medium/longer-term applications will make use of existing and future satellite navigation systems with some type of augmentation or combination of augmentations required for operation in a particular phase of flight.



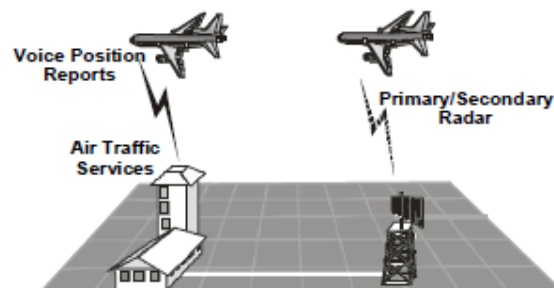
# World Geodetic System – 1984 (GPI-20)

- ICAO adopted in 1994 the World Geodetic System — 1984 (WGS-84) as a common horizontal geodetic reference system for air navigation with an applicability date of 1 January 1998.
- Fundamental to the implementation of GNSS is the use of a common geographical reference system.
- Failure to implement, or a decision to use an alternative reference system, will create a seam in ATM service and will delay the full realization of GNSS benefits.
- Completion of the implementation of the WGS-84 Geodetic Reference System is a prerequisite for a number of ATM enhancements, including GNSS.

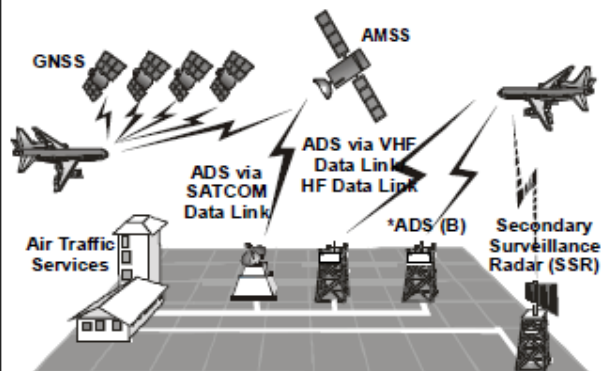
# Situational Awareness (GPI-9)

## Surveillance

Surveillance: Current Environment



Surveillance: Future Environment



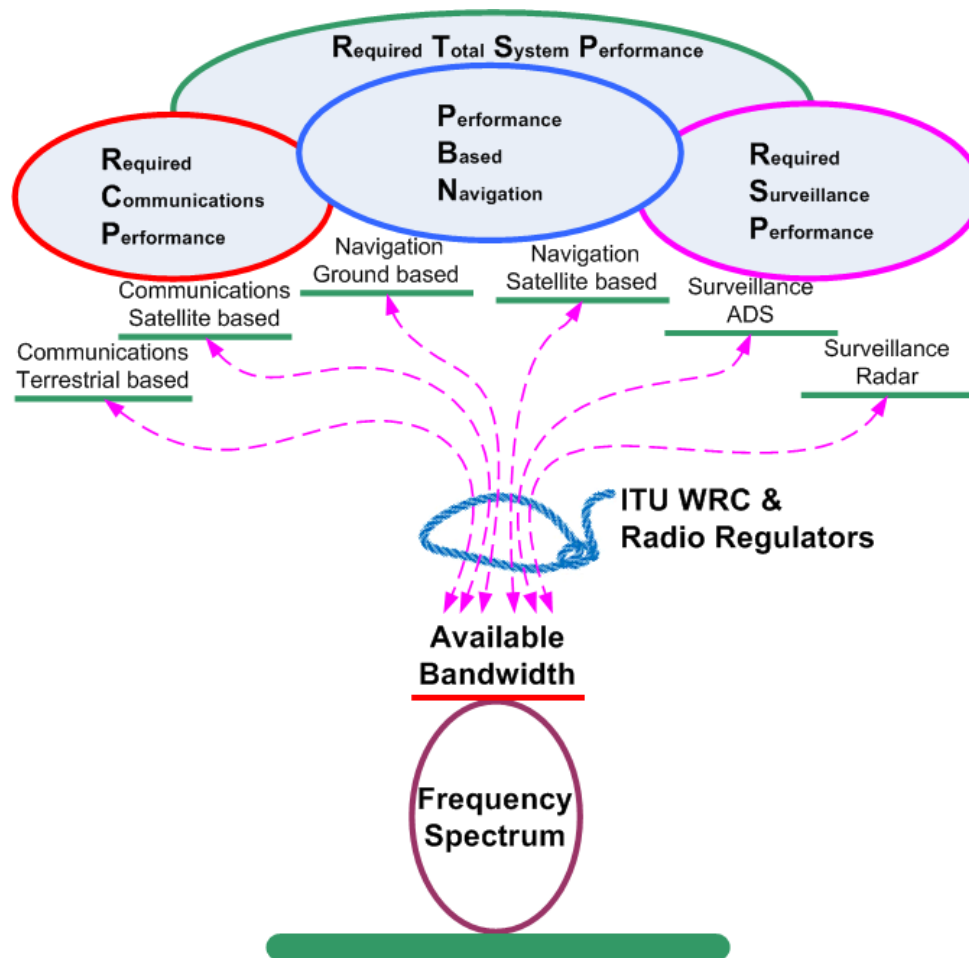
## Situational Awareness (GPI-9) (1/2)

- The further implementation of enhanced surveillance techniques (ADS-C or ADS-B) will allow reductions in separation minima and an enhancement of safety, increase in capacity, and improved flight efficiency, all on a cost-effective basis.
- Implementation of surveillance systems for surface movement at aerodromes where weather conditions and capacity warrant will also enhance safety and efficiency.
- Implementation of cockpit display of traffic information (CDTI) and associated procedures will enable pilot participation in the ATM system and improve safety.

## Situational Awareness (GPI-9) (2/2)

- In remote and oceanic airspace where ADS-C is used, FANS capabilities exist on many air transport aircraft and could be added to business aircraft. ADS-B can be used to enhance traffic surveillance in domestic airspace.
- It should be noted that the 1090 extended squitter is available and should be accepted as the global choice for the ADS-B data link.
- At terminal areas and at aerodromes surrounded by significant terrain and obstacles, the availability of quality-assured terrain and obstacle databases will improve situational awareness and contribute to the overall reduction of the number of controlled flight into terrain (CFIT) related accidents.

# Aeronautical Radio Spectrum (GPI-23)





# Aeronautical Radio Spectrum (GPI-23) (1/2)

- States need to address all regulatory aspects on aeronautical matters on the agendas for International Telecommunication Network (ITU) World Radiocommunication Conferences (WRC).
- Particular attention is drawn to the need to maintain the current spectrum allocations to aeronautical services.
- The radio spectrum is a scarce natural resource with finite capacity for which demand from all users (aeronautical and non-aeronautical) is constantly increasing.
- The ICAO strategy on aeronautical radio spectrum aims at long-term protection of adequate aeronautical spectrum for all radio communication, surveillance and radio navigation systems.

## Aeronautical Radio Spectrum (GPI-23) (2/2)

- The process of international coordination taking place in the ITU obliges all spectrum users (i.e. aeronautical and non aeronautical) to continually defend and justify spectrum requirements. Civil aviation operations are expanding globally creating pressure on the already stressed and limited available aeronautical spectrum.
- The framework of this initiative involves the support and dissemination by States of the ICAO quantified and qualified policy statements of requirements for aeronautical radio frequency spectrum agendas for ITU World Radiocommunication Conferences (WRC).
- This is necessary to maintain the current spectrum allocations to aeronautical services and ensure the continuing availability of adequate aeronautical radio spectrum and ultimately the viability of existing and new air navigation services globally.

# Conclusion

The meeting is invited to:

- note the work assigned to APIRG concerning the development of a regional CNS technology roadmap to serve as the common source of planning guidance for AFS investments by all stakeholders in the civil aviation community, and assist States in;
  - addressing the current deficiencies;
  - implementing CNS-related Global Plan initiatives; and
  - ensuring compatibility between air navigation systems; and
- accordingly propose relevant inputs to be considered by APIRG when developing a regional technology roadmap for aeronautical fixed services (AFS).

# Questions?

- Thank you