IBAC Technical Report Summary

Subject: Global Navigation Satellite System

Meeting: ICAO GNSSP WG's "A" & "B", Brussels April 2002

IBAC File: Navigation

Reported by: Capt. Heinz Lichius

Summary: The main focus of the work was preparation for the ICAO 11th Air Navigation Conference. Consideration was also given to the Concept of using combinations of Independent Constellations e.g. GPS, GLONASS and GALILEO. Note; currently only one satellite system, GPS, is fully operational. These deliberations suggested that transition to combined constellations service could commence circa 2010.

Updated information on the status of GALILEO planning was presented to the meeting.

Work is essentially complete on the draft of a GNSS Manual to replace the ICAO Circular (#27) Guidelines for the Introduction and Operational Use of the Global Navigation Satellite System.

The WG's reviewed the proposed Agenda for the GNSSP/4 Meeting to be held in April 2003.

Additonal detail is contained in the unabridged report of Capt. Lichius attached hereto.

Implication for Business Aviation:

No imminent operational or technical impact.
Account of the outcome of this work should be noted in context of IBAC preparation for ICAO 11th Air Navigation Conference (2003).

Decisions Required:

None.

ICAO GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) PANEL

Working Groups A & B

Brussels April 2002

The second week of the ICAO Global Navigation Satellite Sytems Working Groups A&B was opened by Ross Bowie, rapporteur of A and Eric Chartre, rapporteur of B.
One dominant subject was the 'Preparation for the 11th Air Navigation Conference' 2003.

The current strategy of ICAO (Annex 10) is not to be tied on any special equipment, but consider economical and visible necessity.

ILS continues indefinitely, next to MLS. GNSS should be the main part of the navigation system, and should be maintained as long as it proved its benefit.

It was highlighted again and again of not favouring only one system, but opt for those systems which are best suited for the job.

The time frame for all the work envisaged to read 2025.

In the ensuing discussion it was found , for operational purposes, a classification of performance levels should not be: LARGE and SMALL aircraft, but rather *sophisticated* or *less-sophisticated* aircraft. Here at this point of the deliberation, it was again found that next to the authorities, manufacturers, ICAO and IBAC it would be quite beneficial when IATA would follow the frequent invitation to join these working groups, now preparing the input for the next ANC Meeting.

We then entered the deliberation on the CONCEPT OF USING COMBINATIONS OF INDEPENDENT CONSTELLATIONS (e.g. GPS, GLONASS and GALILEO) The ICAO CNS Concept was adopted at the 10th Air Navigation Conference (September 4-20, 1991) [at this Conference IBAC was invited to state its position within this future work and I had the priviledge to submit a lecture, based on the valuable compilation done by Bill Stine, to bring to the representatives of more than 150 States our position within the aviation community in focus]. This Concept was derived from the ICAO Future Air Navigation System (FANS) studies. At the conference, a "Global co-ordinated plan for the transition to the ICAO Future Air Navigation System" was discussed.
As of 2002, only one satellite navigation system constellation (GPS) is fully operationa and it has been widely adopted. SARPS have been written for both GPS and GLONASS (L1) single frequency signals and for their augmentation through airborne based (ABAS), space based (SBAS) and ground based (GBAS) augmentation systems.

In the future, GPS is to be xtended by providing a further signal within the ARNS band (L5) and will possibly include a world – wide ground integrity channel (GPS/III), The fully operational GLONASS system (24 Satellites) is planned to recover after 2007. Since 2003 the constellation will be added by modernised GLONASS-M satellites with improved characteristics. From 2006 the GLONASS system will be added by a new generation satellites named GLONASS-K. Planning is also proceeding for a third constellation called GALILEO. Galileo will also provide its own augmentation through a world-wide gound integrity channel (GIC). It will provide three signals within the ARNS bands (L1, E5a,E5b). This leads to the need for ICAO to study the ways

in which all these new signals might be used to benefit civil Aviation. With a view for the transition planning towards a GNSS “sole navigation service” as suggested by users, provided its feasibility and the confirmation of its safety and cost benefit are demonstrated.

Robustness improvement against service interruption by combining independent systems is very usual in aviation to achieve the required availability and continuity of service levels. However, GNSS has the particularity to be able to achieve not only robustness improvement but also performance improvement by combining independent signals and/or constellations.

It has to be recognised that in safety of life applications, it is usually difficult to achieve improvement simultaneously on robustness and performance using two sources rather than one, when sole service situation is envisioned. The main reason is that when the improvement in performance is brought by the simultaneous use of two sources, a failure on any one source would directly impact the improved service level, thereby increasing by a factor 2 (considering that the probability of failure is equivalent on the two sources) the probability of failure with respect to the case where a single source would be used. A typical example of this situation in the GNSS context is the use of two frequencies to improve accuracy by ionospheric error compensation at user receiver level.

Therefdor, at this stage, the GNSSP assumption is that the main interest of aviation community in transition toward a sole service mainly based on a combination of constellations would be the improvement of GNSS service robustness against service interruption,

GPS, GLONASS and GLILEO will offer independently operated satellite constellations. The number of common modes of failures possibly occurring at space and ground segment level between any combination of two constellations will therefore be extremely reduced (one may identify very severe solar activity or intentional acts of destroying simultaneously parts of the space and/or ground segments of different constellations.

GALILEO intends to provide signals compatible with GPS on the L1 and L5/E5a frequencies and an additional independent signal (E5b). Hence receivers capable of processing independently all frequencies and both constellations would have very limited common modes of failure.

For any new signal/constellation an additional time period of one to two years would probably be needed for the purpose of validation/certification by civil aviation authorities before approving signals use on safety of life applications. This shows that the transition to combined constellations service could start in the 2010 time frame.

Other potential combinations than GPD/GALILEO should be investigated. For example the GPS/GLONASS/GALILEO combination could be considered to bring additional benefit on robustness due to a third level of robustness to common modes of failure at ground and space segment level and also at user segment level due to GLONASS L1 frequency independency of GPS and GALILEO L1 and also Frequency Division Multiple Access (FDMA) scheme.

The present Galileo status reads like this: Following on from the unanimous conclusions of the Barcelona European Council on 13-14 March, the Council of Transport Ministers released on 26 March 2002 the € 450m needed to develop GALILEO, Europe’s satellite navigation and positioning system, and at the same time adopted the regulation establishing the joint undertaking responsible for implementing it. The Council agreed also among others that GALILEO is a civil programme under civil control and that GALILEO should be interoperable with existing satellite navigation systems.
The GALILEO project, which has been developed in conjunction with the European Space Agency, will now move ahead with the development of gthe final system.
The now starting development phase of GALILEO (2002-2005) aims to validate the technical options and create all the conditions needed for rapid deployment of the infrastructure, including the launching of the first test satellites. Financing of this phase will be provided by the European

Union, with a total of € 550m, and the European Space Agency Agency (ESA), for which ESA Council approved a commitment of € 550m on November 15th, 2001.
Management will be provided by a joint undertaking whose founder members are the European Union and the European Space Agency.

The GALILEO infrastructure will be implemented in three phases:

1. 1. Development and validation phase (2002-2005)

   Consolidation of Mission Requirements;
   Development of satellites and ground-based components;
   Validation of the system "in orbit"

2. 2. Deployment phase (2006-2007)

   Construction and launch of satellites;
   Installation of complete ground segment;

3. 3. Operational phase (from 2008)

Definition of RADIO NAVIGATION AID :

The second meeting of Working Group A of the Separation and Airspace Safety Panel (SASP), held in Montreal 29 October – 9 November 2001, raised the question of the lack of a definition of the term *navigation aid*, and the existence of a number of different terms throughout ICAO Annexes and PANS documents which are used to refer to navigation aids. It was determined to support the idea of introducing a definition, and develop a draft definition which would satisfy the needs of SASP. Our Panel was requested for a view on this matter.

A limited review of ICAO Annexes and the PANS-ATM (Doc 4444) revealed numerous examples of varying terminology for navigation aids throughout: These included *navaid, ground-based radio navigation aid, ground-based electronic aids* and *self-contained airborne navigation aid.* However, no specific definitions are available for these terms.

It appears that the term radio navigation aid should include GNSS, since GNSS is one of the systems included in Volume I of Annex 10. However, in thecontext in which the term is used in the material produced by SASP, it is not considered to include self-contained airborne navigation systems. For example, the guidance material on approval of such systems for RNP 10 refers to the need, in certain circumstances, for updating of aircraft navigation systems using navigation aids.

The meeting recognized that if a definition was developed, updating all the relevant documents to ensure standardisation of terminology across all documents would be a ,ajor task. The view of gthe project team is that it would be worthwhile to pursue a definition in the documentation to at least provide a standardised understanding of what exactly is meant by radio navigation aid.

SASP has proposed the following draft definition:

> *Radio Navigation Aid.* A facility or system external to the aircraft that generates electro-magnetic signals to be used by aircraft navigation systems for position determination or flight path guidance.

At its meeting in September 1999, GNSSP Working Group A decided to develop a *GNSS Manual* to replace *Circular 267 – Guidelines for the Ingtroduction and Operational Use of the Global Navigation Satellite System (GNSS).* There were several reasons for this decision: States wishing to approve and support GNSS operations can benefit from ICAO guidance; Circular 267 was out of date; a Manual, unlike a Circular, can be amended; there is a need for a document to supplement the SARPs by providing operational guidance; and there is a need to provide current information to match the sometimes unpredictable progress of GNSS technology. Working Group A focused on developing the *GNSS Manual* at three meetgingd in London, New Delhi and Philadelphia, with editorial group meetings between formal working group sessions. Working Group B participated in the review during the Rio de Janeiro meeting.
The editorial group met in January 22002, incorporated changes and produced Version 6 Final Draft. Following the Brussles Meeting, the Secretary will review Version 6, make changes necessary and forward the revised document the Secretariat for processing. The Secretariat will perform further editing and return the document to the Secretary, who will forward this version to the rapporteur of Working Group A.

The Group reviewed the presented Agenda for the GNSSP 4 Panel Meeting in April 2003. The Panel Secretary reminded everyone that the agenda had to go to the ANC for Aproval by September of this year. Coordination of the Draft Agenda with the Panel Members has to be completed by the end of July 2002. It was suggested that the Meeting duration should be 8 working days, and the proposed dates are from 23 April to 2 May 2003 (subject to coordination within the ICAO Secretariat.

The next (and last prior to GNSSP/4) meeting of working groups should be held in late October – early November 2002, either in the United States (to be confirmed by 1 June 2002) or in Montreal (as suggested by the Panel Secretary). This will be a Working Group of the Whole meeting.

Respectfully submitted by.
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GNSS Member IBAC.