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Satellite navigation systems and procedures

Geneva, January 2012. Contrary to the widely-held view that all satellite navigation can be subsumed under the "GPS" banner, aviation actually has a range of satellite navigation systems and procedures at its disposal today, all of which offer more possibilities than conventional navigation technologies. Here we provide an overview of the most important satellite navigation systems, and explain how the corresponding new procedures are developed.

1. Satellite navigation systems

GNSS (which stands for "global navigation satellite system") is an umbrella term for systems which are used to navigate and determine current position based on signals received from dedicated navigation satellites. There are currently four GNSSs in use or being developed worldwide:

- the **Global Positioning System (GPS)**: a system that has been developed by the US Department of Defense since the 1970s, and has been fully functioning since the mid-1990s
- **GLONASS**: a system developed by the Russian Ministry of Defence since the 1970s that became fully operational in 2012
- **Galileo**: a project co-launched by the European Union and the European Space Agency at the beginning of 2000 to develop a satellite navigation system for civil purposes. The first Galileo services should be available in 2014, but the system will not be complete until 2020.
- **Compass**: China's satellite navigation system, which has also been under development since the beginning of 2000 and should also be fully functioning by 2020.

GNSS satellites transmit navigation signals and their position by radio. An aircraft needs to receive such signals from at least four satellites simultaneously to determine its position.

2. Supplementary systems

To verify the accuracy and reliability of the signals they use, the existing satellite navigation systems are further supported by three types of "augmentation system": aircraft-based, satellite-based and ground-based.

Aircraft-based augmentation systems or ABASs use sensors on the aircraft to give pilots additional information that can help them check the GNSS data they receive and correct these if necessary. ABASs are installed aboard most modern aircraft today.

Satellite-based augmentation systems or SBASs enhance the accuracy and reliability of GNSS positioning data by transmitting correctional signals to users via geostationary satellites. Unlike the global GNSSs, however, SBASs are limited to certain regions of the world. There are currently three SBASs that are of relevance to the aviation sector:

- **WAAS**, the USA's Wide Area Augmentation System, which is in service
- **EGNOS**, the European Commission's European Geostationary Navigation Overlay Service, which is also in service
- **MSAS**, Japan's Multi-functional Satellite Augmentation System, which is in service, too.

Russia and India are also developing their own SBASs.

Ground-based augmentation systems or GBASs also enhance positioning accuracy and reliability by providing system users with additional information. Unlike SBASs, however, GBASs are generally limited in their use to the areas around airports. GBASs are also seen as a supplement to (and a long-term replacement for) the present instrument landing systems (ILSs) used with airport runways. As such, GBASs provide the foundation for precision landings using satellite navigation technology.

3. Flight procedures

The satellite navigation systems which are currently in operation permit a wide range of different flight procedures. They also offer more options than are available with conventional navigation systems. Such options include the possibility of continuous descent operations (CDOs), the flying of curved approaches and the adoption of the "points-in-space" approach.

The underlying navigation systems that are required to permit the adoption of these procedures differ in terms of both their accuracy and the investment costs involved. The decision whether to adopt a particular navigation system and the associated flight procedures will also depend on:

- the needs of the **airport** concerned: the system's availability, for instance, can be affected by local topography and/or the prevalence of particular weather conditions

- the needs of **airspace users**: the demand for shorter routes, for example, or for reductions in fuel consumption

- the **equipment available**, aboard the aircraft and at the destination.

For air traffic management, the main incentives for determining new flight procedures are in areas such as separating arriving and departing traffic and raising overall system efficiency. Reducing noise and pollutant emissions are further key considerations.

Every new flight procedure adopted will be individually tailored to the requirements of the various partners involved. Needless to say, all established safety standards will continue to be rigorously observed, or will even be enhanced in the process.

Skyguide assists and advises the commissioning parties concerned – the airports and their operators – in all their decision-making on whether and how to further refine their existing navigation systems and flight procedures, and works with them to find the best possible solutions.

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factsheet

skyguide
swiss air navigation services ltd.
media relations
CH-1215 Geneva 15

contact:
phone: +41 22 417 4008
email: presse@skyguide.ch

internet: www.skyguide.ch

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