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Rapid Emergence of New Technologies Spurs Debate About Precision Landing System Priorities

Development is under way on several new technologies that will greatly improve precision landings. A U.S. report says careful research and resource planning is the key to the timely implementation of the most effective system.

Editorial Staff Report

Failure by the U.S. Federal Aviation Administration (FAA) to commit enough resources to research several emerging precision landing system technologies could cause costly and unnecessary delays in improving the current system, the U.S. General Accounting Office said.

The FAA is sponsoring development of several systems to improve significantly the nation's aging instrument landing system (ILS), including the microwave landing system (MLS) and a satellite-based system that uses the U.S. military's global positioning system (GPS). The FAA is also developing an ILS system that will be enhanced by a computer-based flight management system (FMS) on board the aircraft.

All the systems have the potential to offer greater precision landing capabilities than the ILS, but the benefits and costs differ, the GAO said. The GAO, an independent U.S. government monitoring agency, also warned that rapid developments in technology threaten to make some systems obsolete as they are being installed.

In a recent report, *Airspace System: Emerging Technologies May Offer Alternatives to the Instrument Landing System*, the GAO said that "although the FAA's development of the MLS is a prudent step, the FAA's decision to replace the ILS with the MLS is premature because the capabilities and benefits of the MLS may be provided by emerging alternative systems. Some airlines are already installing components for these other systems to support aircraft operations during all phases of flight."

The GAO said that the FAA should commit enough resources to develop all three systems (GPS, MLS and ILS/FMS). "This would put the FAA in the best position to make future decisions on precision landing systems, which require major investments by the FAA and users."

"If the FAA commits insufficient resources to the development of all alternatives, the consequences could be significant," the GAO said. "The agency may be unable to provide users with the benefits of the ILS/FMS combination in the near term because new approach procedures will not be

completed. In addition, the FAA may not know whether the satellite-based system is feasible by the mid-1990s, when the agency intends to decide on the full production of MLS and will need to know if it has other options."

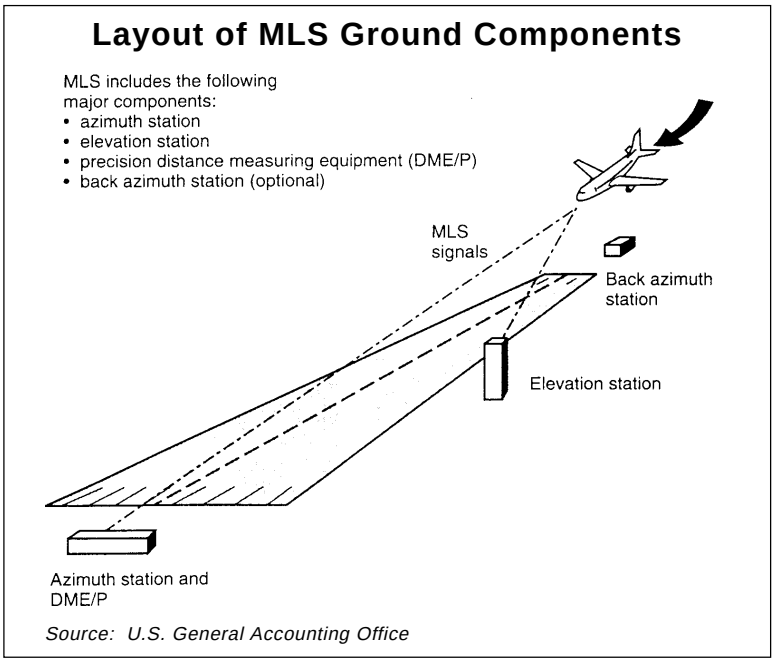


Figure 1

In the 1970s, the FAA and the International Civil Aviation Organization (ICAO) committed to developing MLS, which overcomes most limitations of the ILS, including frequency congestion and radio frequency (RF) interference from adjacent-channel frequency modulation (FM) transmitters. The MLS signal provides for a wider range of coverage than the ILS signal, thus allowing aircraft to fly multiple approach paths, including curved approaches and steep approaches to an angle of 15 degrees. "Thus, aircraft will be able to land in areas where the ILS cannot be installed," the GAO said (Figure 1).

The ILS/FMS combination, while supporting some advanced approach procedures, is still subject to several of the problems encountered with the ILS, such as frequency congestion and interference. The ILS facilities now in use were installed in the late 1960s and 1970s and maintenance and logistic costs are increasing with age.

Since the commitment in the 1970s to develop the MLS system (with a target implementation deadline of 1998), significant alternative precision landing systems have emerged, such as the potential of a GPS network, the GAO said. "The FAA's current plan, based on a 1978 decision, is to procure 1,250 MLS [stations] to replace 836 ILS [facilities] and to satisfy the need for additional precision landing systems."

"Both the MLS and the satellite-based system are expected to overcome problems of the ILS, but full development and installation of these systems may take many years," the GAO said. The FAA estimates that it will require 10 years to convert to MLS, and at least another five years before the ILS can be decommissioned.

The MLS program is the second most costly item in the FAA's capital investment plan, the GAO said, with US$2.6 billion earmarked to develop, procure and install the MLS stations.

"Calculating costs for users on the basis of projected MLS costs of [McDonnell] Douglas and Boeing aircraft, it would cost users between $252 million and $336 million to equip the entire U.S. fleet of about 4,000 commercial aircraft. The costs for MLS avionics may be higher because some airlines have expressed interest in dual or triple MLS/ILS or MLS/GPS receivers."

But it added: "Although the FAA is devoting substantial resources to develop the MLS, the GAO and aviation industry representatives are concerned that the agency is committing an insufficient level of resources to develop the ILS/FMS combination and the satellite-based system. For fiscal year 1993, the FAA's congressional budget request was $6.8 million to develop satellite navigation applications." The GAO said the agency needs $15.1 million to achieve objectives outlined in the FAA's satellite navigation plan.

The FAA criticized the GAO assessment, saying that it did not fully acknowledge the FAA's recent efforts to evaluate the satellite-based system.

FAA Acting Administrator Joseph Del Balzo in April 1993 told a U.S. congressional committee that the FAA decided not to commit to production of MLS until the agency determined whether GPS was capable of providing coverage of Category II and III approaches.

Del Balzo said the FAA will make a determination on GPS capabilities in 1995, in time for an ICAO conference on precision landing systems that year. He said MLS implementation could be delayed beyond 1995 if further GPS assessment is warranted. The GAO told the U.S. Congress it wanted the FAA to be required to conduct a runway-by-runway analysis to determine where MLS systems are needed. "The FAA needs to assess alternatives such as satellite-based systems and their expected impact."

The GAO noted that "few of the major or regional airlines ... are planning to switch to the MLS."

"Many airline and general aviation representatives believe that by the time the development of the MLS is completed, the satellite-based system will be able to

provide at least Category I precision landing services," the GAO said. [MLS is expected to support Category I, II and III precision approaches and landings.]

The FAA is working with the U.S. Department of Defense (DOD) and U.S. airlines to develop a satellite-based system that can be used for both military and civilian purposes (Figure 2).

"This system will initially be based on GPS, a satellite-based radio navigation system designed to provide multiple aviation, maritime and surface users with continuous and highly precise navigation and time information anywhere on earth and in any weather condition."

GPS can provide navigational support in flight between airports and during approaches and Category I landings. Category II and III capability is not yet possible and is under development.

"The satellite-based system currently has potential limitations because it will need enhancements to satisfy the requirements for a precision landing system," the GAO said. "A precision landing is required to provide accuracies of a few meters [yards], give warnings about the integrity of the system's signals within seconds of detecting a problem and be available almost all of the time. These enhancements will be technically challenging and require significant resources."

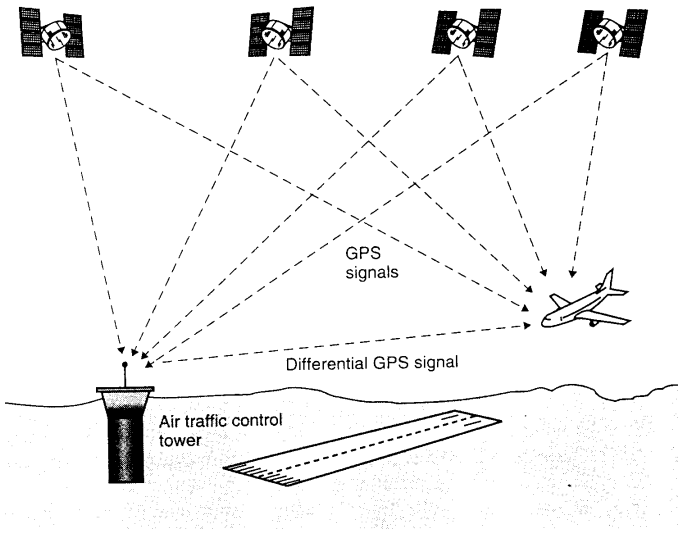
A ground-based signal transmitter could be used for a supplementary differential signal to increase GPS position accuracy to a few meters, which will satisfy Category I requirements; accuracy must be less than 1 meter to satisfy Category II and III requirements.

The report said: "The GPS offers two levels of services to calculate position: (1) the precise positioning service (PPS) and (2) the standard positioning service (SPS). PPS allows military and other authorized users to calculate [a] highly accurate three-dimensional position (latitude, longitude and altitude) to about 16 meters [53 feet]. SPS can also allow users to calculate highly accurate positions. However, for national security reasons, SPS is being degraded by DOD so that civil users will only be able to calculate position with an accuracy of about 100 meters [330 feet]. When SPS is not being degraded, it has shown accuracies of between 21 and 53 meters [69 and 175 feet].

"Enhancing the GPS to permit the satellite-based system to be used for precision landing is technically challenging. When the needed enhancements are completed, this system is not expected to have the ILS' limitations. For example, like the MLS, the satellite-based system will permit aircraft to fly multiple approach paths, including curved and steep approaches. Compared with the ILS and the MLS, which can provide service to only one end of a runway, the satellite-based system is expected to provide precision landing service not only to both ends of a single runway but also to all the runways within an airport. Similarly, the system may permit aircraft to navigate on the airport surface as well as in the air routes between airports, thereby eliminating the need to use separate navigation equipment during different phases of flight."

The GAO said that the U.S. system can be used in conjunction with other aircraft navigation systems, including inertial navigation system (INS), long-range navigation (Loran-C) and the former Soviet Union's global navigation satellite system (Glonass).

Layout of the Satellite-based System for Civil Aviation



Note: The differential signal provides the aircraft with data to correct the position calculated using GPS satellites.
Source: U.S. General Accounting Office

Figure 2

"Initially, the GPS will be used by civilian aviation to complement other navigation systems on board the aircraft. Only when GPS satisfies the accuracy, integrity and availability requirements will it be used by itself as the sole means of navigation."

So far, the DOD has incurred the cost of developing and implementing GPS, the report said. The DOD estimates that it will spend more than $10 billion on GPS, and it will be responsible for operating and maintaining the system, including replacing satellites as needed.

Although the FAA is not paying the costs of operating and maintaining GPS, it will certainly incur significant costs to broaden its applications for civil aviation.

Long-term reliance on DOD maintenance and control has met with opposition from several airline groups, with strident concerns expressed by international carriers and government authorities who have strong objections to U.S military control of a satellite system for civilian use.

Although the precision landing system debate focuses largely on GPS and MLS, the GAO noted that to meet the unique need of many airports, "a mix of systems may ultimately provide the necessary precision landing services." Thus, the ILS/FMS combination continues to be an option.

The GAO report said that several major airlines view the ILS/FMS combination "as a bridge to the MLS or the satellite-based system."

"The ILS/FMS combination is attractive to the airlines because the ILS is already in place, and FMS technology ... is increasingly being installed on commercial aircraft. Also, the FMS can provide benefits, such as capacity enhancements and time savings, that result from curved approaches. In the future, the FMS could use navigation information provided by the Global Positioning System (GPS) to compute highly precise curved approaches."

Originally, the FMS was intended to support en route navigation, but with its sensors, the FMS can process incoming data in and around a terminal. Also, it can compare an aircraft's current position with its intended flight path. The GAO report says a number of U.S. airlines are testing the ILS/FMS combination to develop landing and departure applications. But the report says the system also has long-term drawbacks.

"Although the ILS/FMS combination has the potential to provide benefits to the airlines in the short term, these benefits are limited for two reasons. The ILS/FMS combination will still be affected by some of the ILS' limitations, such as frequency congestion, FM interference and operations impaired by weather. The system will only provide benefits to a limited number of users, mostly commercial and business users. Most general aviation users will not benefit from the enhanced system because of the cost of the FMS."

The expense of the ILS/FMS combination will fall on both the user and the FAA as advanced approach procedures are developed and the combination is certified. The GAO says FMS packages cost between $500,000 and $775,000 per aircraft. It said about 20 percent of the aircraft of major U.S. air carriers are equipped with FMS and about 50 percent are projected by 1995.

"If airlines are to use the ILS/FMS combination for advanced approach procedures, such as curved approaches," the GAO report says, "FAA must continue to maintain, replace and upgrade the ILS. Furthermore, FAA must develop these approach procedures. Once these procedures are developed, FAA must certify the ILS/FMS avionics to be used for curved approaches. These requirements involve a commitment of FAA staff.

"According to the Air Transport Association [of America] (ATA), this commitment may require more staff than FAA currently has working on procedural development and certification, and FAA's 1993 budget request does not ask for staff for this purpose. As a result, ATA has recently asked [the U.S.] Congress to provide 30 additional staff members over three years." ♦

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