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NAVIGATION ARCHITECTURE INDUSTRY DAY

A NEW DAWN FOR WORLD RADIONAVIGATION

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## I. INTRODUCTION

On 7 May FAA called an “Industry Day” meeting at MITRE Corporation, McLean, VA. The meeting was co-hosted by Mike Harrison, head of the ATC Architecture Office of FAA, and Mike Shaw, Director of Radionavigation in the Office of the Secretary of Transportation.

The invited attendees included representatives of the various aviation associations - ATA, RAA, NBAA, AOPA, ALPA, NATCA, ILA, ATCA - many national and regional airlines, aircraft manufacturers, ATC providers, and consultants. Neither the press nor Congressional representatives were present.

In the morning DOT and MITRE executives made presentations.

In the afternoon each of the groups present was invited to comment on the DOT’s presentations. In recognition of his five year advocacy of ATC redundancy (no GPS sole means), the DOT convenors asked Langhorne Bond for concluding comments.

The meeting revealed the government’s changes to ATC architecture in response to the Volpe Center’s report on GNSS (GPS) vulnerability, the heightened awareness of the risk of terrorist attack post World Trade Center, and the Rumsfeld Commission’s report on satellite vulnerability in the new era of space warfare. The changes are obviously designed to assure a high level of ATC security and constitute a significant change in philosophy, which will likely be followed worldwide.

## II. NO GPS SOLE MEANS

The DOT has finally and formally abandoned the doctrine of GPS as the sole means of navigation in aviation.

A clarification of terms is in order here. "Sole means" indicates that an aircraft depends only on GPS for en route navigation, terminal maneuvering, precision and non-precision approach, and ATC surveillance (ADS-B). Avionics dependent on ground based systems would not be carried. This is a policy directly affecting safety as well as security.

"Sole service" is different. Sole service by GPS means that all terrestrial navaids would be shut down. The FAA has long stated that GPS sole service will not be implemented any time soon, thus allowing the somewhat delayed GPS augmentations to mature and also allowing existing avionics suites to live out their economic lives. But FAA has previously refused to recognize that GPS sole means cannot be attained.

Vulnerability, terrorism, and space warfare have killed GPS sole means: a redundant terrestrial positioning system will be required on aircraft.

### III. AIRCRAFT REQUIRED TO CARRY A BACKUP SYSTEM

— All FAR 121 aircraft: big airliners

— All FAR 135 aircraft: air carrier aircraft under 30 seats, and charter aircraft

— FAR 91 will not be required to carry a backup system. However, a backup is required to enter Class A, and Class B airspace in IMC, so nearly all GA aircraft will carry a terrestrial backup.

### IV. ILS

All Cat II & III ILS's will be continued.

Some Cat I ILS's will be continued. Specifically, at least one Cat I ILS in each airport will be continued; however, airports with more than one

Cat I ILS will be reduced to one. This will require all IFR aircraft, including air carriers, to equip with WAAS and LAAS.

V. LAAS

It was announced that LAAS cannot now do Cat II & Cat III, but can do Cat I.

It would cost \$25 million to achieve Cat II and \$50 million to achieve Cat III. However, since all Cat II & III ILS's will be continued there is not much reason to spend the money to get LAAS to Cat II & III, so it may never be done.

Also, the distance between the LAAS monitoring station and the LAAS transmitter can be no greater than 5 miles (alternate version: 3 miles). So LAAS is basically a one airport system and will not serve nearby airports in the local area.

Several airlines were heard to say that they now do not plan to equip with LAAS.

VI. DME

All DME's in the NAS system will be continued. Since all modern Flight Management Systems (FMS) are driven by multiple DME's (DME scanning), DME's will constitute an en route and terminal maneuvering backup to GPS. DME/DME navigation is a high accuracy system and loss of GPS will not be noticeable to most FMS-equipped aircraft on most operations.

About 75% of the air carrier fleet is FMS-equipped, as are virtually all modern biz jets.

This brings FAA in line with EUROCONTROL policy, which has always recognized DME/DME as a GPS backup.

## VII. VOR

VOR thus remains a navigation system used mostly by small GA aircraft.

FAA plans to de-commission half the current VOR's, mostly in the East. The goal is to provide VOR service at 5,000 feet and above. This will permit GA aircraft to climb to 5,000 feet, acquire a VOR, and find an airport in the event of loss of GPS.

## VIII. AIRCRAFT EQUIPAGE COST

The requirement to carry terrestrial backup systems means that there will be no future savings to operators through reduced avionics. However, since virtually all aircraft are now equipped with terrestrial systems, no additional costs are incurred. When WAAS and LAAS receivers are certified, IFR aircraft will have to equip - and retro-fit - with them, according to current FAA plans.

## IX. NAVAID DECOMMISSIONING

The plan revealed on 7 May does contemplate significant decommissioning of some nav aids, thereby saving the government some costs.

A. ILS. Many Cat I ILS's are slated for removal, although at least one Cat I ILS will be continued on each airport that now has one.

One airline representative stated that ILS will now continue to be the primary precision approach system and they would be reluctant to endorse removal of any ILS's.

FAA response was that a precision approach via WAAS would be available, though not to a 200' DH, and some airports would also have LAAS Cat I.

- B. VOR. Approximately half the VOR's would be removed, leaving service above 5,000' assured everywhere.

An increasing number of GA aircraft are GPS equipped, and with GPS available the VOR reduction would not ordinarily be a navigation loss. In the event of loss of GPS, however, the small GA aircraft would not have much service below 5,000'. Continuation of the DME's, so useful to FMS equipped high end users, would be of little use to small planes which are not FMS equipped.

Continuing the DME's at most of the VOR sites would keep the sites active and thereby avoid the environmental clean-up costs if the sites are completely closed down. Remediation of each VOR/DME site could exceed \$1 million.

- C. NDB. All federal NDB's, except possibly those at outermarkers, would be decommissioned.

## X. SURVEILLANCE

ADS-B could be used to feed controller radar screens for ATM surveillance purposes. However, all current ADS-B units are driven only by GPS, and GPS can be lost.

Therefore, all secondary, transponder based radar will be continued and all IFR aircraft will continue to carry SSR transponders.

And all primary radar - "skin paints" - will be continued for purposes of homeland defense.

## XI. GPS LOSS SCENARIOS

The FAA/DOT presentation illustrated several GPS loss scenarios. These were all local or regional in nature, such as would be caused by jamming. FAA will develop operational strategies to deal with this and get aircraft safely on the ground. Of course, carriage of backup systems is the ultimate mitigation strategy for any GPS outage, but development of GPS outage strategies is still a useful task.

However, jamming is not the only threat to GPS.

In the future, America and its allies' enemies may not be operating out of caves. In the era of Space Warfare, attacks on satellites, including GPS satellites, are a virtual certainty. This has been spelled out in the recent, highly credible Rumsfeld Commission report. In this case, a GPS outage could be widespread - perhaps worldwide - and could extend for a long time.

If this occurs, it is not sufficient for the ATC system to get aircraft safely on the ground. The ATC system without GPS must continue to operate at the highest possible level of capacity or else risk economic chaos.

This raises the question whether the decommissioning of hundreds of Cat I ILS's is advisable.

## XII. FREE FLIGHT

One of the key elements of the future ATC system is ADS-B, a critical part of the terminal elements of the free flight program. ADS-B is currently driven only by GPS. So in the absence of GPS, ADS-B would go down, with a resultant loss of capacity and efficiency.

At the 7 May meeting the United Airlines representative mentioned in passing that United's ADS-B units would be driven both by GPS and DME/DME. This is technically very simple and is a perfect backup for ADS-B for use by air carriers in congested airspace.

### XIII. TIMING

GPS atomic timing was briefly mentioned. It is now known that much of FAA's current and future communication and surveillance systems are dependent on GPS timing and will collapse if GPS and WAAS are lost. It was stated that these systems are being converted or redesigned to incorporate free-standing cesium or rubidium clocks.

However, these clocks will drift out of tolerance in a short time without a continuing satellite or other primary source. Again, it appears that this solution reflects the view that GPS outages would be limited in area and duration.

The only continuing, very secure timing source is LORAN, the transmitters of which are currently being fitted with modern, GPS-equivalent, timing signal generators. But the long term future of LORAN being undecided, FAA cannot yet adopt this superior timing source.

### XIV. OVERVIEW

The changes to US aviation navigation policy revealed on 7 May are excellent steps in the right direction, but are far from a perfect outcome. The backup system of reduced terrestrial nav aids, all old line-of-sight technology, provides very poor coverage away from the big airports. Regional airlines and nearly all GA users will be losers.

Equally significant, the cost savings once predicted for satellite navigation have now almost all evaporated. Users must continue to carry all the old gear as well as new satellite boxes. And the government is saddled with high costs of the sat nav projects as well as maintaining a dense array of line-of-sight nav aids.

There will be significant international repercussions. The new policy is a rejection of the conclusions of the Applied Physics Lab/Johns Hopkins University study which concluded that GPS/GNSS interference could be "managed." This hotly contested study has been cited many times outside the U.S. No more.

Instead DOT has accepted the conclusion of the Volpe Center's GPS Vulnerability Report that a backup to GPS/GNSS is needed.

#### XV. LORAN

The future of LORAN was briefed by Mitch Narins of FAA and was discussed. OMB has directed DOT to come to a decision on LORAN by the end of the year. Mike Shaw described LORAN as "theoretically the ideal" backup nav system but said that one or more of the modal administrations had to state a future requirement for LORAN. Since paying in whole or in part for LORAN goes with endorsing it, some internal maneuvering, and perhaps Secretarial leadership, lies ahead.

LORAN technology offers the only long-term cure to the problems of poor service and high cost. The LORAN transmission signal follows the surface of the earth and provides a high accuracy signal to the runway surface to nearly every airport, large and small, in the US, and a worldwide array of LORAN transmitters is already in place serving

perhaps 80% of the world's commercial flight. It is, as Keith McDonald of the US GPS Industry Council says, a perfect backup to GPS, where needed.

And the future cost savings will be impressive. The twenty-five US LORAN stations can, in the long run, replace all 1,000 VOR/DME sites. For OMB and the Federal budget, LORAN can be an enormous economy.

Like all navigation systems, however, LORAN will take time to develop and phase in. Users will want to run out their current boxes before the switch. Governments do not think well in the long term, and certification of integrated GPS/LORAN receivers is several years away. But when that time comes, the benefits to GPS, the improvements to service, and the cost savings will be dramatic.

XVI. THE LATEST VERSION OF THE DOT/DOD FEDERAL RADIONAVIGATION PLAN  
... is inoperative.

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N.B. All of the presentations on 7 May by FAA/DOT and MITRE, including FAA's response to the Volpe Center's Report, plus MITRE's summary of the user comments, are available on the Internet at:

<http://www.mitrecaasd.org/comm/conferences.html>