The Coming Of Age of Aviation LORAN

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I. INTRODUCTION

You may be startled to find someone talking about LORAN to a European aviation conference. I know, no airplanes in Europe are equipped with LORAN avionics. But hear me out.

Here is a partial list of avionics with which no aircraft were equipped once upon a time: VOR; DME; ADF; ILS; MLS; GPS; WAAS; EGNOS GALILEO; LAAS (GBAS); ADS-B; CDTI; and CPDLC.

Now they all are on board or soon will be. The logic of each system compelled their adoption. So it will be with LORAN.

II. GNSS SOLE MEANS: TULIP MANIA

In the early days as satellite positioning, navigation and timing (PNT) emerged we were all bedazzled by its amazing coverage and accuracy. The myth arose that GNSS was perfect…a complete system that would permit us to discard every single ground based navaid. As time went by, however, reality intruded. Splendid as GNSS was, it had its limitations.

There are two principal limitations, either one of which would prohibit GNSS sole means.

- Vulnerability. The satellites in a medium earth orbit of 11,000 miles transmit at just 20 watts of power. The ultra weak signal strength received on earth is one watt to the minus 16 power-one ten quadrillionth of a watt. Our receivers work fine when they get a clear signal, but the signal is often corrupted by natural phenomena, such as solar storms, and by man made transmissions such as TV, radar, and other stray RF signals. Most alarming is intentional interference such as jammers and even attacks on satellites. The famous Volpe Center report of 10 September 2001 laid it all out.

- Single Thread. GNSS navigation is basically a sole source signal. There is no back up, unless we adopt one. A basic rule of aviation safety is: sooner or later, everything will fail. We love and require redundancy. Fail safe design brings us home safely.

Of course, not every GNSS user needs a back up if the loss of GNSS has no intolerable consequences. My GPS car navigator comes to mind, as do backpacker units. But where safety of life is at stake we must and will have a redundant dis-similar positioning source to team with GNSS for every phase of flight-enroute, terminal, and approach.

Let me quote an unimpeachable source: the technical committee of CANSO, representing the world's ANSPs, in "Demystifying GNSS"

> "…it is most unlikely that GNSS will become the only means of navigation on a universal basis as originally envisioned by ICAO".

III. WHAT DO WE ADOPT IN THE FUTURE?

All you GNSS enthusiasts can relax. GNSS/GPS will be on every aircraft as the fundamental basis of aviation navigation. But to make GNSS/GPS secure and widely accepted, a terrestrial backup is needed.

Today aviation is protected because we have VOR/DME, NDB, and, for oceanic flight, inertial systems on board. But this dense array of complicated transmitters (more than 3000 in the US!) is a living display of obsolete technology. It is vastly expensive to the users and provides poor service, especially to business and general aviation.

So we must transition to a better, cheaper terrestrial system as quickly as we can. Of course, we must never forget that virtually all aircraft are equipped with the older systems and it would be costly to retrofit. But we must also remember that the users are now paying for every centime of the operating cost of the older ground stations.

Our task, then, is to select the best long term backup, install it on all new aircraft, and work out a transition schedule that makes the most financial sense to users and ANSPs. What to do?

IV. THE AGE OF LORAN

The solution is LORAN. That's spelled L-O-R-A-N for the benefit of you aviation folks in Europe who haven't thought about it for years, perhaps ever. LORAN is in the future of aviation.

Let me tell you about it briefly. LORAN uses an extremely strong, long wave, low frequency signal with a wave length of several kilometers. The older terrestrial systems have a much higher frequency with a much shorter wavelength. This difference has profound consequences. The older systems have a line of sight signal. If you are over the horizon or behind a building or mountain you are out of luck. No signal. That is why the US and the developed world are covered with a thicket of VORs, DMEs, and NDBs- at great cost to the users, with big gaps in coverage in spite of the vast array.

LORAN is different-and much, much better. The LORAN signal follows the surface of the earth, and can even penetrate buildings. In fact, you can get a good positioning signal from multiple LORAN stations in a valley or behind a

mountain. Try that with GPS or VOR/DME. And LORAN, because of its tall antennas and megawatt power, has immense range. When FAA turned on its test receiver in Atlantic City it picked up fifteen LORAN stations at distances exceeding 2000 kilometers when the plane was sitting in front of the hanger.

LORAN is now understood in the PNT world as a modern, reliable, accurate signal that is the perfect complement to GNSS.

Recently the EU published its first draft proposed European Radionavigation Plan (ERNP). The draft ERNP, developed after much consultation, listed LORAN as a core technology for Europe and set out a possible path to extend LORAN throughout all Europe. It also placed Loran at the very top of the cost benefit chart.

V. ACCURACY

After the publication of the Volpe Center Report, which was virtually coincident with the 9/11 attack, Secretary Mineta of the US DOT set in motion an exhaustive series of tests and studies to determine, once and for all, the performance of LORAN. The results were published last January. LORAN passed every test.

Not only were the problems with older versions of LORAN-such as P static and chain dependency-now solved by modern antennas and receiver electronics, the accuracy was found to be excellent.

As an aviation navaid, LORAN has a lateral accuracy of RNP 0.3! Which is of great interest to this conference on RNP. LORAN can meet the requirements of enroute navigation, terminal maneuvering, and non-precision approaches (NPAs).

-To the air carrier user, LORAN is a complete replacement for DME/DME systems at a much lower long-term cost.
-To the business and general aviation users, who do not have expensive DME/DME systems, LORAN is the only back up to GNSS for non-precision Instrument approaches at the 80% of European airports without an ILS.
-For ADS-B, which will be the foundation of future ATC surveillance, LORAN is the only feasible backup in case GNSS is lost. In this role, LORAN is needed now: ADS-B has no positioning redundancy.

No one suggests that in aviation LORAN should be used alone. GNSS is the primary system of the present and the future. But future receivers should, and I believe will, include GNSS and LORAN. Integrated aviation receivers are now flying with two US manufacturers with excellent results.

LORAN is the best friend GNSS ever had.

VI. COST

The cost of putting the LORAN signal in space is ultra-low, as the draft ERNP and several US studies stated. The entire continental United States is served by just 18 LORAN stations, with routine operating costs for the automated stations (all of them) well under a million dollars each.

But there is more. The VOR/DME/NDB systems now used in aviation are used almost exclusively by aviation, so aviation users pay the entire cost.

LORAN, like GNSS, will provide positioning and precise time services to a host of users, as listed in the draft ERNP-mariners, container trackers, and nearly all telecommunications systems.

The US Coast Guard, to its chagrin, is unfairly burdened with the entire cost of operating the entire US LORAN system. I expect this to change soon under a recent Presidential GPS directive to spread costs more fairly.

So the aviation users of LORAN will end up paying a small part of a tiny total cost.

LORAN is the best friend GNSS and the aviation users ever had.