Improving Signal Quality

Watts Antenna Company realized long ago that being a leader in the Instrument Landing System (ILS) business is not for the faint of heart. Pronouncements on the demise of ILS are routine. Yet despite a succession of wannabe usurpers ILS always manages to stay relevant. Contrary to some observers who regard ILS as a static solution, the technology evolves all the time. Finally, when it comes to the very crucial task of delivering aircraft safely out of the clear blue sky to the tarmac below, schedule delays, cost overruns and elaborate augmentation systems start to sound like nothing *but* blue sky.

Take this month's *Inside GNSS* where the cover story is about ionospheric scintillation and the 2013 solar max. Talk about scintillating reading! This is not the sort of doomsday tone one expects when reading about the premiere backbone of the nation's Positioning, Navigation and Timing (PNT) system. An August 2006 white paper for the FAA (*"GPS Backup for Position, Navigation and Timing Transition Strategy for Navigation and Surveillance", Aviation Management Associates, Inc.)* characterized PNT as a vital service on par with power and water, indeed central to the maintenance of the nation's social fabric. The ATA paper hardly minced words. In fact it italicized them: *"Remove that basic foundation [PNT], and the ugly products of opportunism and desperation set in."* Frankly the whole thing makes ILS multipath sound like a walk in the park. As for the frequent charge that ILS is fundamentally an old technology, we wonder whether the opposition is attempting to cast system maturity and reliability in a negative light. What's wrong with the tried and true, especially when it's been embellished with some recent enhancements?

Though the prevailing technologies and their acronyms often change (MLS, TLS, GPS, LAAS, GBAS, RNAV, RNP, et al), ILS's vulnerabilities are all-too familiar. The most common criticisms are the unacceptable reductions of airport landing capacity during Instrument Flight Rule (IFR) conditions and the limitations placed on airport development. At this time, the picture is clouded as to what system(s) will provide precision approaches in the future (and to what degree ILS will inhabit that future.) Despite the uncertainty, some manufacturers and researchers remain committed to ILS development. Interestingly, though the press on ILS is sporadic (in contrast to NextGen's crown jewel GPS III), the forecasts remain stubbornly optimistic. The general consensus is that ILS will inhabit a niche for a very long time (see inset quotes below.) That said the length, breadth and depth of that niche remain a subject of broad conjecture.

"GPS needs dissimilar, complementary, multi-modal & independent source of PNT (to include ILS)" --Institute for Defense Analyses (Jan 2009)

"Many Category I instrument landing systems (ILS) would be retained to fulfill precision approach capabilities as a backup to ensure safe recovery of aircraft and continued operation of air commerce in the event of GPS interference. All ILSs used to support Category II/III operations would remain in service." --GPS Backup for Position, Navigation and Timing Transition Strategy for Navigation and Surveillance, Aviation Management Associates, Inc. (Aug 2006)

"FAA plans to retain a minimum network of VOR, DME and ILS facilities to serve as a backup to GPS for the near future…" –2008 Federal Radionavigation Plan (p. 3-9)

Recent ILS development efforts, though always precarious undertakings, have not been in vain. Soon all that will remain of ILS constraints will be irreducible physical issues, (i.e. required taxiing aircraft safe displacement from centerline and application of obstacle free zone criteria), as opposed to ILS-indigenous shortcomings arising from its radiated signal and related multipath effects. Another inevitable challenge will emerge in the area of spectrum management as nascent technologies make their case to the FCC for highly-coveted bandwidth. The FM radio industry occupies adjacent spectrum and is a vocal ally of GPS, for obvious reasons. In short, ILS has few cheerleaders. Nor is the NextGen/GNSS public relations blitz

doing much to burnish the ILS image.

People unfamiliar with ILS advances over the years may be conditioned towards a cost-at-all-costs purchasing rationale. Herein lies the paradox: *The "least expensive" ILS may actually be the costliest for a host of reasons that go beyond merely the system price tag.* If minimal airport development is expected over the ensuing five years, then perhaps system cost remains the driving factor, and the least expensive array is a valid choice. However if significant development is expected then airport consultants would do well to direct their customers towards more expensive arrays. The marketing challenge is exactly that, a challenge. But it's not a bill of goods. The value is there.

With the threat of broad-scale ILS decommissioning always looming on the horizon, ILS equipment manufacturers have had little choice but to be incremental and measured in their development and system design efforts. Indeed Watts has characterized the ILS development arc as being one of "fixing the problem rather than fixing the system." With NextGen deployment a top priority in the U.S. and GNSS the talk of the industry, a fifteen year development plan for ILS seems ill-advised. However this is no different from the prior fifteen years when ILS obsolescence was equally "assured". Not surprisingly, ILS funding is dwarfed by the GPS behemoth. That's why programs tend to be more geared towards Service Life Extension Programs (SLEP). Because it is financially unwise to develop an antenna to meet the needs of only one airport, restrictions are put in place at that location to preserve the quality of the signal. Only when a number of airports have restrictions that limit capacity and expansion, does market demand support development of a new array to address the combined need.

For now, ILS development finds itself artificially constrained by poor planning and vague public policy directives. This uncertainty feeds a vicious circle as sluggish ILS development becomes further reason to promote ILS phase-out. Quoting again from the AMA Report:

"The lack of clear policy leads to greater cost for navigation. An example is the lack of policy on the ILS. In the absence of good federal policy on establishment of ILS's, the Congress has earmarked a considerable number of locations over the years to where today, the FAA is maintaining a significant number of installations where the benefit is marginal and the annual cost is growing."[p.25]

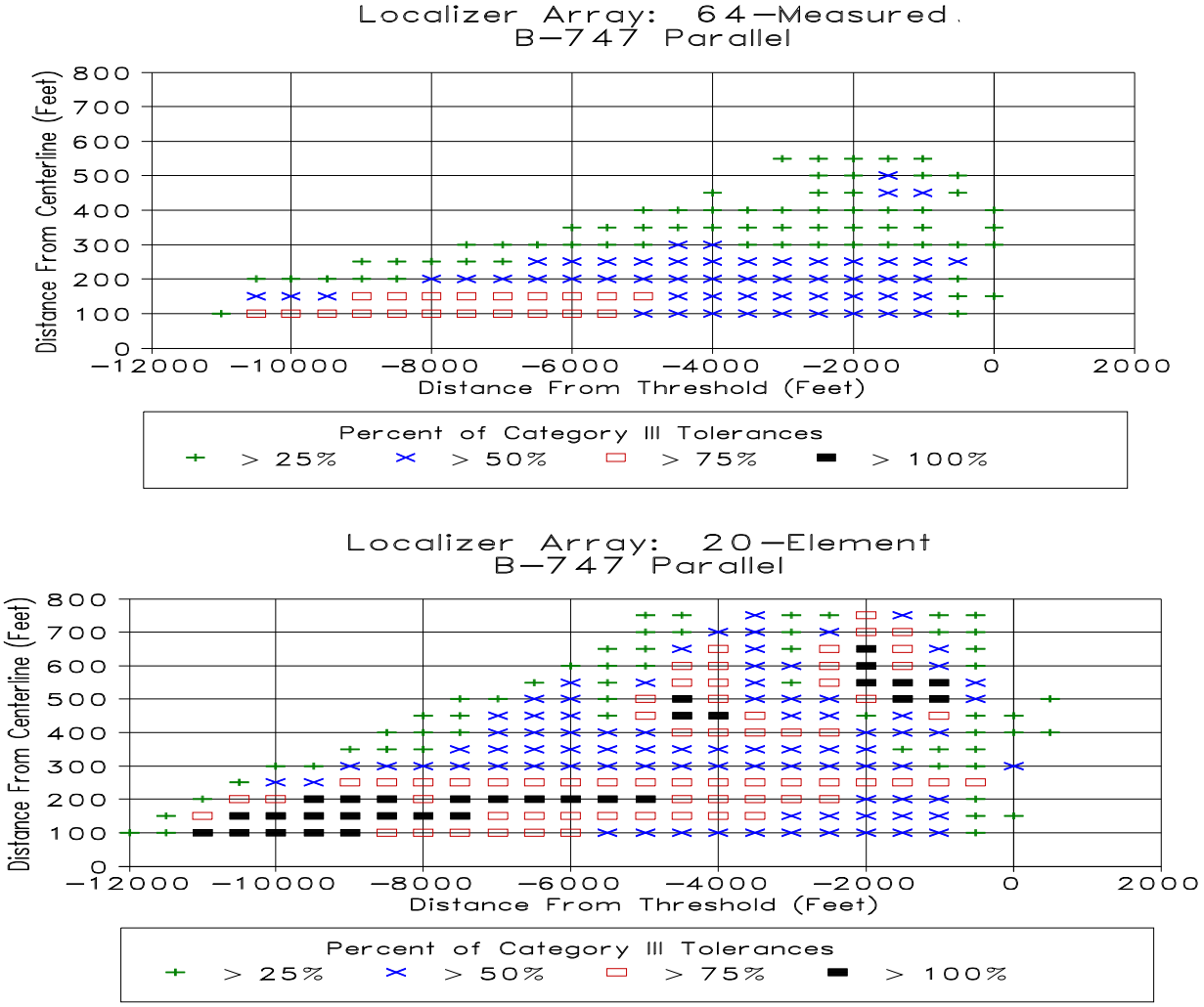
Indeed an argument can be made that the GPS marketing effort has overreached (one might say, succeeded beyond its wildest dreams) by adopting a scorched-earth policy towards other "competing" technologies (such as eLoran and ILS) when those technologies are not direct competitors at all. Not only is the world big enough for GPS, ILS and Loran, our infrastructural vitality depends on these backups and redundancies. No less than the "father of GPS" Dr. Brad Parkinson conceded in the *European Journal of Navigation*: *"I am a supporter of having a backup radio navigation system [to GPS], and the only backup system I can see is Loran. And I can see further that GPS helps Loran or Loran helps GPS. I think that's a great idea. It is mutually aiding, depending on the type of integration."*

Like Loran, ILS suffers from a similar industry disdain brought on by its perceived legacy status. However in its own precision landing niche, the same redundancy argument applies. The AMA report amplifies this point in a national defense context: *"From a security standpoint, the best defense against an attack on GPS is to lower the target value by providing a sufficiently robust national backup that allows PNT to continue in a way that there is a significantly reduced safety risk and direct impact on our economy."*

With little fanfare, Watts Antenna Company has developed and perfected over the last few years a wide aperture ILS localizer with a course array aperture of 270 feet. The common aperture used in the U.S. and abroad for CAT II/III approaches is between 130 feet and 165 feet, so this is a long antenna. It helps to recall that the radiation beam-width, in azimuth, is inversely proportional to the horizontal aperture. The wide aperture limits the amount of incident radiation in the direction of buildings and taxiing, or holding, aircraft. The result is a reduction in undesired multipath signals that arrive in the on-course region to

corrupt the guidance information. The wide aperture ILS antenna, due to the narrow beam, is less sensitive to new construction and provides greater freedom of movement of aircraft without affecting the guidance information being used by an aircraft on final approach. Field tests of the antenna radiation patterns have been confirmed by extensive flight measurements.

An extensive computer modeling study was conducted in February 1999 by the Ohio University Avionics Engineering Center, in Athens Ohio, USA. A comparison was made, for all modeling cases, with three accepted Category III type ILS commonly found throughout the world at difficult sites. Modeling simulated a perfectly conducting hangar of dimensions 1,000 feet (L) x 100 feet (H), and offset 1,200 feet from the runway centerline. The theoretical building was located at fifteen different locations along the runway and 13 different orientations in each location, representing a total of 195 cases. A Boeing 747-400 class aircraft was also modeled to evaluate capacity improvements during IFR conditions. Expected improvement regarding capacity during IFR conditions can be evaluated by comparing Figure 2 with Figure 3 (below.) The symbols represent the percentage of allowable category III course structure tolerances that is expended by the presence of the aircraft.



The aircraft was modeled parallel to the runway and perpendicular to the centerline in 435 positions in each orientation for a total of 870 cases. Modeling results confirmed a substantial reduction of the ILS critical area, suggesting considerably greater airport development opportunities when a wide aperture ILS is employed.

Unfortunately, marketing efforts for this new ILS capability have been greeted with skepticism from many industry insiders. Landing system experts in the United States often counter with "we don't need it yet but the day will come, we are sure". Meanwhile airport owners and operators are waiting for the free services of GPS/WAAS and development of LAAS, more commonly referred to now as GBAS. As for the international community, the comment is often "yes, but we are going to MLS" or "my customers may consider this solution as overkill." Of course one customer's overkill is another's feature enhancement. Watts forges ahead undeterred.

Then there is the sense that, whether orchestrated or not, a certain disinformation campaign appears to have clouded recent ILS advances. One article, "GPS - An Airline User's View", in the Royal Institute of Navigation's September 1995 issue of the *Journal of Navigation* states that, *"the runway capacity at London Airport (LHR) goes from 39 movements per hour in VFR conditions down to fifteen movements per hour in Cat III conditions, much of which is directly attributable to the changes required to protect the ILS beam."*

The article goes on to discuss interference problems in Brussels and downgrading of its ILS from Cat III to Cat II. Further emphasis is given to, *"Cardiff Airport, where construction of the new British Airways hangar has severely 'damaged' the ILS signal."* In the Cardiff case, contact was made with the appropriate authorities to promote evaluation of the new ILS antenna as a solution to their problem. The response was that, while their Category I requirements could be better met by upgrading their ILS, the airport was very busy and could not afford the operational disturbance long enough to facilitate the test. Another interesting example cited in *Global Airspace* indicated that MLS was necessary at Schiphol Amsterdam due to ILS limitations. However offers to test the new development at Schiphol were politely declined by local authorities in 1996.

Watts Antenna Company remains convinced the future will find a place for ILS as it always has. Surely this has been the lesson of history: We proceed in the belief that providing a robust, proven technology for a mission-critical function can never be a vain exercise. However the navigation community, particularly its public policy component, could do the industry a great service by articulating a more explicit ILS strategy. Only then will the appropriate R&D funding coalesce around a coherent and comprehensive NextGen ILS solution.

Watts is making NextGen happen *now*.