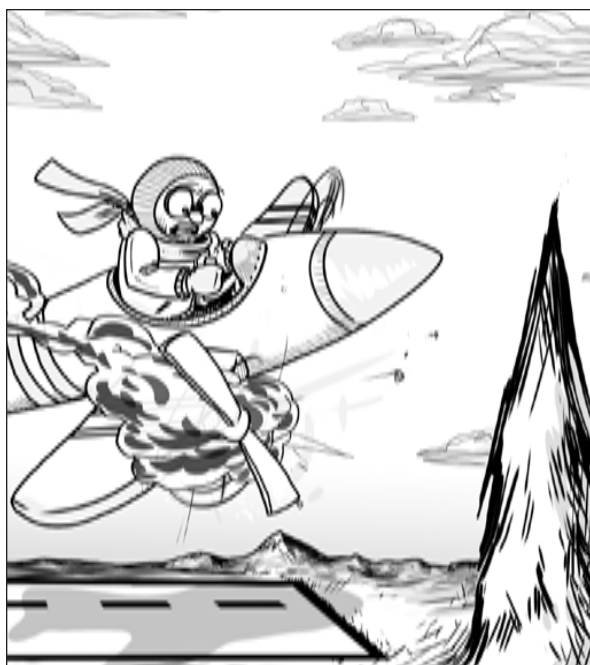


The Magazine for the Accomplished Pilot



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HOW WILL LAAS BE MORE?

WAAS's more-accurate brother has been slow in coming. Some approaches are available today as well as the equipment to fly them.

by Fred Simonds

Our current collection of VORs, ILSs, DMEs, NDBs, marker beacons, and lighting systems comprises over 3000 pieces of equipment. In fiscal 2004 (not exactly yesterday), they cost FAA over \$300 million to maintain. Part of the rosy NextGen plan is to cut costs and improve capability by purging the system of all those expensive marker beacons, NDBs and VORs. Even the venerable ILS will trundle into history after a distinguished career dating back to 1949.

The Wide-Area Augmentation System (WAAS) approaches we

have now are capable of replacing Cat-I ILS with DAs as low as 200 feet above the threshold. But that's not enough for the Cat-II and Cat-III approaches transport-category aircraft need for all-weather operations.

Enter the Local Area Augmentation System, or LAAS. Now let that term go. The international term is Ground-Based Augmentation System, or GBAS. GBAS is sometimes used to describe *all* ground-based correction systems (the military has one called JPALS), but "GBAS" seems to be where the FAA is drifting with its terminology for what we think of as civilian LAAS, so that's what we'll start saying, too.

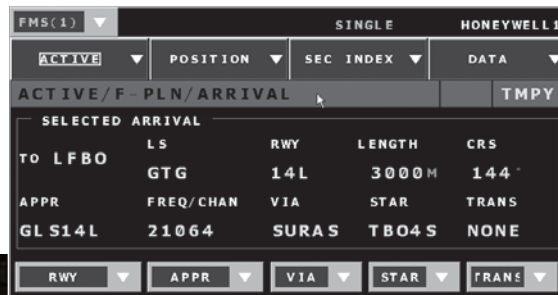
GBAS promises enough accuracy to replace any ILS system and do much, much more. Delivering on

that promise? That depends on what you mean and who you ask.

Like WAAS, But Local

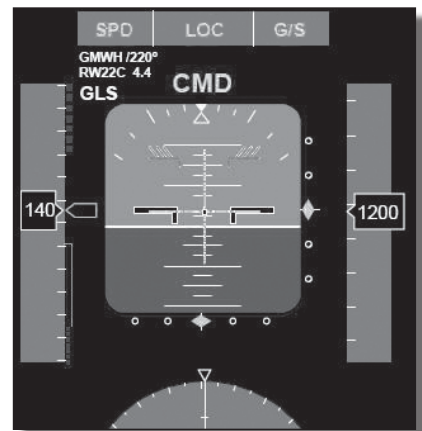
First a quick review of how WAAS works and pumps up the accuracy of your GPS. Back when GPS first hit the scene, the government was a bit skittish about it being used by those with hostile intent. So they let our military have full-accuracy GPS from the satellites but degraded the signal for civil use. This kept the position accuracy at about 100 meters. When that degradation was stopped, GPS position accuracy jumped to about 15 meters. The 15-meter uncertainty is still there because the signal quality, angles, processing, etc., are still not perfect for any given user on any given day.

The WAAS system is a constant-correction mechanism. There are over 20 WAAS ground stations around the U.S. that calculate their position using the GPS satellites and then compare that result to their actual, surveyed location. Did the GPS solution come up six meters southwest of the real value? They send that correction data to master stations. Corrections from each



Left: LAAS/GBAS/GLS approaches will be a feature of transport-category flying first. The approaches will appear in the FMS just like any other approach. The Primary Flight Display will be ILS-like

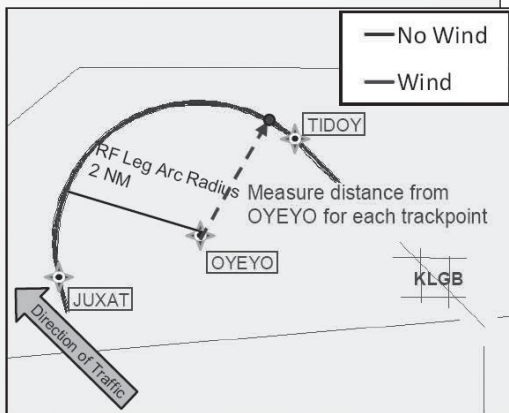
by design for a simple transition, even if part of the approach is a curved path through space.



AT LEAST THE END OF THE APPROACH LOOKS LIKE AN ILS

One of GBAS's more striking potential features is offering variable-geometric lateral and vertical paths for both approach and departure. Nearing the airport, GBAS offers curved approaches called Terminal Area Paths to avoid obstacles or noise-sensitive areas. A curved-path procedure can begin at the fringes of the terminal area and end in a Category I GBAS approach.

Curved path transitions use something called "radius to a fix" to lead aircraft efficiently to the final approach segment, improving traffic flow and circumnavigating weather without radar intervention. Con-



ceptually, radius to a fix is similar to a DME arc: The aircraft will fly a constant distance from the fix on a curving path. This should be familiar to most current GPS pilots.

RNAV (RNP) approaches with curving paths, both for the approach and the missed, are already in use by some air carriers in select locations. What's new here is using the GBAS system for the position accuracy and having the curve terminate with a precision approach. Note that there are LNAV/VNAV and LNAV versions of this approach with specific RNP requirements. GBAS is part of a bigger picture.

Vertically, GBAS supports offset landing thresholds (landing further down the runway) and variable glideslope angles. It also supports segmented glideslopes, meaning that part of the approach is at one angle and the rest is at another. These features improve wake avoidance and reduce noise footprints. They also foster continuous-descent approaches, which save enormous amounts of fuel.

The bigger picture is that controllers will be able to adapt to current weather and traffic conditions from a menu of predefined Terminal RNAV routes. Similarly, Dynamic Routing will

KMWH
GRANT CO INTL

JEPPESSEN
27 SEP 02
SAMPLE

MOSES LAKE, WASH
RNAV or GLS-W Rwy 32R

ATIS 119.05	*GRANT CO Approach (R) 126.4	SEATTLE Center (R) 126.1 when App inop.	*GRANT CO Tower CTAF 118.25
RNAV or GLS	Curved Path	Final Apch Crs 324°	GLS DA(H) 1364'(200') Apt Elev 1185' TDZE 1164'

MISSED APCH: Climbing RIGHT turn to 4000' direct to BATUM and hold.

1. RNP 0.1 required. 2. DME/DME RNP with OPERATOR authorization. 3. Procedure not authorized below -17°C (2°F). 4. Pilot controlled lighting 118.25.

4000'

MSA RW32R

SAMPLE CHART FOR EVALUATION PURPOSES ONLY

	WH301 4700' (3536')	WH302 4000' (2836')	FF32S 2800' (1636')	WH303 1600' (436')
	2.0	3.2	3.1	
	[TCH 56'] TDZE 1164'			

Gnd speed-Kts	70	90	100	120	140	160			
Descent Angle [3.50°]	434	557	619	743	867	991			

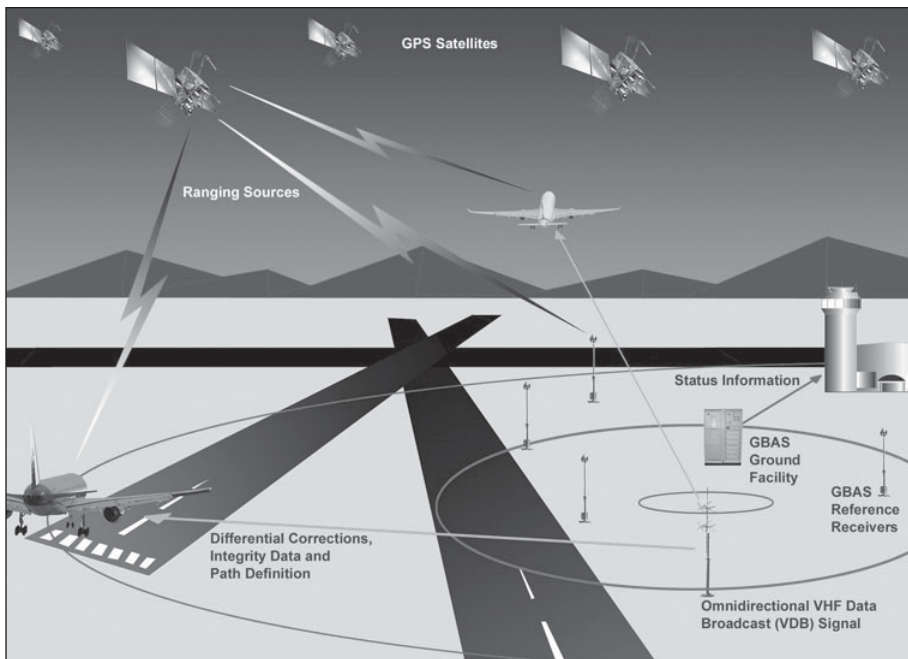
GLS DA(H) 1364'(200')	LANDING RWY 32R LNAV/VNAV (RNP 0.1) DA(H) 1414'(250')	LNAV/VNAV (RNP 0.3) DA(H) 1560'(396')
FULL	RAIL out ALS out	RAIL out ALS out
A		
B		
C	RVR 24 or 1/2	RVR 40 or 3/4
D	RVR 60 or 1/4	RVR 50 or 1 RVR 60 or 1/4

CHANGES: New chart. © JEPPESEN SANDERSON, INC., 2002. ALL RIGHTS RESERVED.

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offer them a selection of predefined routes to get around fast-moving weather.

To prevent all these options creating a workload nightmare for the crew, the final approach segment will be uploaded to the airplane by the GBAS datalink for you to review and set up. The data link also promises to reduce pilot-controller transmissions during critical stages of flight. And this datalink should be free, so long as we don't slip into user fees. —F.S.



Left: Here's the PowerPoint view of what GBAS should look like. The point is that the GPS correction is on the airport or within a couple miles. That offers both super accuracy and easy monitoring.

ground station could be different, so the master stations make a master correction signal and pump that up to a WAAS satellite that relays it to you.

Your WAAS GPS calculates its position using the GPS satellites and then applies the appropriate net correction for its position from the WAAS signal. The final position solution usually has an accuracy of less than three meters. There are subtleties to the system that we're glossing over here, but this will do for our purposes.

GBAS puts this correction system right on the airport, so the correction signal is even more precise. Within the airport boundaries (well, actually, somewhere within six kilometers of the runway threshold),

four reference GPS receivers are strategically placed, and accurately surveyed. Each receiver computes its location and compares it with the survey. These receivers, however, send their differential information to a ground station on the airport.

The station averages the corrections from each reference receiver and broadcasts composite correction data to surrounding aircraft within 20 to 30 miles on a ground-to-air VHF datalink. In a choice bit of irony, these frequencies will be those once used for ILS localizers and VORs.

An airborne receiver applies the corrections to each satellite that both it and the ground station see. The receiver then only uses satellites for which it has corrective data. This

probability increases as the airplane nears the GBAS stations, so accuracy improves as the airplane approaches the airport.

The aircraft's box is called a multi-mode receiver, or MMR. It supports GPS,

WAAS, GBAS and even good-old ILSs and VORs—a few of which will be kept as backups. MMRs are sold today by Rockwell-Collins, Honeywell and others.

The GBAS World vs. ILS

GBAS's corrected, lateral accuracy should be less than or equal to one meter for a Category I GBAS. Compare that to 16 meters for a Category I ILS localizer. Accuracy could be as good as one meter laterally and vertically. Availability should also improve from 98.6 percent for an ILS to 99.9 percent, or better, for GBAS.

There are additional benefits. GBAS approaches all have GPS distance and a glideslope—no more localizer-only approaches. (Also, no glideslope antenna means the system can't be snowed under by a plow.) The alarm system for a Cat I ILS shuts down the localizer within 10 seconds of detecting a malfunction; six seconds for the glideslope. For GBAS it will be under two seconds. There is no periodic inspection requirement, which eliminates disruption of airports due to flight inspections.

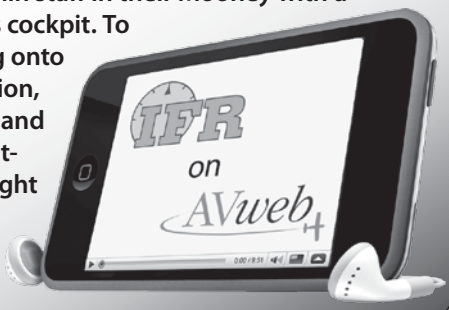
Lacking an ILS beam, there will be no ILS critical areas to avoid. Elimination of these areas might seem little more than a convenience, but their absence could improve departure flows and rates by eliminating hold-short restrictions that constrain capacity at many airports. LAAS signals resist weather and interference better than ILS. In terms of trust, GBAS uses a figure of merit called a Probability of Hazardously Misleading Information. For GBAS, that probability is one in 10 million.

GBAS could do things we have always needed but never thought to request. For instance, it could track

(continued on page 18)

VIDEO Technology and Approaches: Cockpit View

We can't show you flying GBAS approaches from the cockpit just yet, but we did get a chance to fly approaches with Garmin staff in their Mooney with a G600 retrofit glass cockpit. To see it in action, log onto our sister publication, www.avweb.com, and click the VIDEO button in the upper right of the page. Look for the link on the G600 flight.



then talk to a briefer, although he confides that these new guys just don't offer much more than his own eyes and experience can gather.

He uses approach plates from a government book—no MFD approach charts in his airplane. He does pay for datalink weather and wishes he had onboard radar, too. He makes a habit of watching how weather progresses in flight. He never listens to music, but he's been known to read the newspaper while on autopilot.

Keith briefs every takeoff, even just for pattern work. Keith briefs every approach, out loud, exactly as he does in the jet. He'll go around if the approach isn't stabilized by 1000 feet AGL and he never drops below an MDA. But he'll admit to "lazily starting the missed" at DA on a well-stabilized ILS or LPV approach. He's been known to land with less than the required visibility if he feels comfortable with what he can see.

Upset that so professional a pilot might bend the rules a bit? Understandable, yet Keith drives by a visceral sense of what he feels is acceptable risk first, and by what the regs say second. He counts on decades of experience to make that call.

Put this in perspective with this little fact: Keith will soon quit the Falcon job and he says he may soon after limit his IFR to en route only or not at all. For him, experience and proficiency are two pillars that hold up the arch of his flying. One time can only add to. The other weathers away easily and can leave you with a false sense of safety.

That's not a bad philosophy no matter what style of IFR you fly.

Jeff Van West is the editor of IFR.

HOW CAN LAAS BE MORE?

continued from page 8

aircraft on the ground, including airport service vehicles, to reduce runway incursions. Departures and

missed approaches could have precision guidance.

GBAS and WAAS complement each other. Recent software upgrades mean that over 99 percent of the airports in the U.S. and southern Alaska are eligible for a WAAS LPV approach at an estimated cost of \$20,000 per approach. GBAS installations would cost much more and would only be at larger airports. However, one system can provide coverage for every runway at the airport, and even for nearby airports.

Still Flying the Needles

Operational procedures are deliberately similar to those we use today for the ILS. By sticking close to familiar instrument displays, annunciators and cockpit procedures, crew training is (hopefully) minimized. Approach plates should look like what we know—except for intriguing curves where needed.

Testing how well this all works in practice, a flight crew from the FAA Technical Center flew a series of GBAS approaches in an elderly Boeing 727-200, dubbed the "Jurassic jet" for its lack of cockpit sophistication and sluggish handling. They reported no trouble keeping ahead of the system even at jet speeds.

Continental Airlines crews have made over 250 visual GLS approaches (what GBAS is likely to be called from the aircraft side) into Guam, trained only with a bulletin (studied in advance, one hopes) and no simulator time. Pilots reported favorably on the simplicity of GLS approaches that replicate an ILS but are more stable. They added that their visual-approach performance improved using GLS as a backup, resulting in fewer unstable approaches.

Potholes on the GBAS Path

While GBAS has moved in and out of the R & D due to issues with fault-tolerance and single-point failures, Honeywell has convinced the FAA their system is ready for prime time. In September of this year, the FAA gave system design approval to SmartPath Cat I GBAS, making it

the first system worldwide to meet the ICAO standard. Honeywell has GBAS systems operating in Memphis, Tenn; Atlantic City and Newark, N.J.; Seattle and Moses Lake, Wash.; and Olathe, Kan. They also have setups in Sydney, Australia, and Bern, Germany among others.

GBAS systems will be a part of the larger NextGen effort. The FAA knows that the most critical element in NextGen's success is ensuring that enough of the aircraft fleet is equipped to use it, with critical mass estimated at around 30 percent.

To that end, the FAA seeks to maximize the use of existing equipment, such as FMSs. Some creative financing plans have been floated, including government financing, subsidies, incentives, leasing, and even a national infrastructure bank. Some have suggested that part of the money saved from decommissioning be used to pay for airborne gear. There are decisions yet.

Equipping the airports is still unresolved as well. The FAA doesn't have a contract out to install these systems. The Newark GBAS was actually purchased by the Port Authority, which runs the airport. The airport system is only Cat-I right now, as well. Honeywell must still get the FAA blessing for Cat-II and Cat-III and then update the installed ground system as needed. Target date for that change is 2012.

That's a start, but the ILS maintenance technicians shouldn't fear for their jobs just yet. There's still a chance some other variation of GBAS will trump the one we're working with now as the widely adopted system of choice. But what is clear is that just as WAAS LPV approaches have been proven and now proliferate, LAAS or its equivalent is coming. And it will deliver more than your grandpappy's ILS ever could.

Fred Simonds is a Gold Seal CFII and factory-certified G1000 instructor. See his web page at www.fredonflying.com.